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CONTENTS

ARTICLES PAGE

The Eradication of *Anopheles albimanus* in Puerto Rico—An Ecologic Discussion. John M. Henderson 45

A New "Jeep" Mosquito Control Assembly. T. D. Mulhern 49

Large-Scale Rearing of *Anopheles quadrimaculatus* Say at Orlando, Florida. Margaret Greenwald, J. H. Cochran, and Donald K. Scharff 50

Notes on a *Mansonia perturbans* Problem at Edgewood Arsenal, Maryland. David A. Young, Jr. 57

Studies on the Flight Range of Certain *Culex* Mosquitoes, Using a Fluorescent-Dye Marker, with Notes on *Culiseta* and *Anopheles*. W. C. Reeves, B. Brookman, and W. McD. Hammon 61

Observations of Hibernating Mosquitoes in Massachusetts. Morris Berg and Sheldon Lang 70

Records of *Anopheles quadrimaculatus* Say for the Floriday Keys. Ernestine H. Basham and James S. Haeger 72

A Vespid Preying on Anophelines. H. H. Stage 73

OBITUARY, Dr. Alfonso Dampf 73

NEWS AND NOTES 74

LIST OF ADVERTISERS 76

ASSOCIATION NEWS 77

Report of the March 28–31, 1948 meeting 78

Report of the AMCA Good Neighbor Club 84

EDITORIAL SECTION 86

REVIEWS AND ABSTRACTS 87

Malaria in Brazil. By Mario Pinotti. Fernando Bustamente 87

Malaria Control in Villages of Quetta (Baluchistan) with DDT. By M. K. Afridi and M. L. Bhatia. C. Y. Chow 87

A Brief Account of the *Anopheles* Malaria Eradication in Karpus-Cyprus, 1946. By M. Aziz. Helen Sollers 88

The Importance of Coverage in DDT Residual House Spraying for the Control of *Anopheles quadrimaculatus* Mosquitoes. By R. H. McCauley, Jr., R. W. Fay, and S. W. Simmons. R. H. McCauley, Jr. 88

The Mosquitoes of Illinois (*Diptera, Culicidae*). By Herbert H. Ross. Alan Stone 88

The Olfactory Responses of Female Mosquitoes. By Edwin R. Willis. Wm. B. Owens 89

The Use of Aircraft in the Control of Mosquitoes. American Mosquito Control Association. T. G. Raley 89

BIBLIOGRAPHY SECTION

Periodicals of Interest to Mosquito Control Workers. Helen Sollers 90

References to Literature of Interest to Mosquito Control Workers and Malariologists. H. H. Stage 92

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ARTICLES

THE ERADICATION OF *ANOPHELES ALBIMANUS* IN PUERTO RICO—AN ECOLOGIC DISCUSSION

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Professor of Sanitary Science, Columbia University School of Public Health

PART I

1. Introduction

In a previous article,[1] the feasibility and justification for eradicating the malaria vector, *Anopheles albimanus,* in Puerto Rico were explored. Preliminary consideration was given to both technical and administrative factors involved in the planning and performance of operations for this purpose.

It is the author's opinion that administrative aspects of the subject are at least equal in importance to those of a technologic character, since they include the need for creating a special organization vested by law with unusual powers and staffed with personnel possessing a rare combination of biologic training, and operational and administrative ability. This article, however, will be confined to technologic considerations, principally bionomic in character, in the interest of more adequate presentation of this phase of the problem.

The technologic feasibility of eradicating an undesirable insect species is controlled by four broad variables:

(1) The total biologic characteristics of the species and the extent to which these are known to man; (2) the character and extent of the environment; (3) the species effectiveness of existing insecticidal methods; and (4) the hazards of re-importation. While final judgment demands the synthesis of all four factors, biologic characteristics considered independently offer a convenient approach. Following this procedure, any mosquito species may be placed tentatively in one of the following categories; (1) Easy to eradicate; (2) Difficult; (3) Impossible; and (4) Unclassifiable due to lack of information. These categories are of course relative; even an easily eradicatable species may require prodigious operational effort; "impossible" is used in its practical sense. Present knowledge of the bionomics of *Anopheles quadrimaculatus* and *Anopheles albimanus* suggests placing these species tentatively within the category of "difficult." Although this article is concerned with the eradication of *Anopheles albimanus,* examples of "Easy" and "Impossible" species are cited for perspective.

Hypothetically, the easiest species to eradicate is one that: is highly domesticated in adult behavior and larval habitat, is very selective in choice of breeding place, oviposits only in water, is exclusively androphilic in feeding habits of the mature female, has a short flight range, uses man's habitations as its sole resting place, possesses no significant estivating or hibernating characteristics in the mature stage, and develops rapidly and is susceptible to desiccation in the immature stages. Of the species important to man, *Anopheles gambiae* during dry weather seasons in its brief tenure as an imported species in Brazil and in the Nile Valley, and *Aedes aegypti* in some climatic situations approach, but do not meet, these specifications.

An example at the other extreme, i.e., "Impossible" to eradicate, is provided by

[1] "On the Possibility of Eradicating the Malaria Mosquito in Puerto Rico." Boletin Asociacion Medica de Puerto Rico, XXXIX (3):89–96, March 1947. Presented before Sixth Annual Meeting, Puerto Rico Public Health Association February 5, 1947.

some of the long flying species of the genus *Aedes,* the ova of which may remain viable in nature for several years, which enter and rest in the habitations of man only to a limited extent, and are dispersed in nature after leaving the vicinity of the breeding place. The eradication of such species may be dismissed as impractical at the present time wherever breeding places are numerous and abundance is great enough to constitute a problem.

II. Bionomics and Physiology of Anopheles Albimanus

This species in its West Indian environment may be considered typical of the genus *Anopheles* in most physiologic characteristics. For this reason, much of the general physiology of the species is omitted. The mean temperature for January in Puerto Rico is about 6° F. lower than for July. Accordingly, significant seasonal change in temperature does not exist as a motivation for excessive prolongation of the immature stage, hibernation of the adult, or lengthy pre-hibernating flight. Field experience indicates that the developmental time of the immature stage ranges from 7–9 days to about 21 days, the latter occurring in the winter. The immature stage does not appear to resist drying, nor has prolonged dormancy of the ovum, larva or pupa been noted in Puerto Rico under any other circumstances, although little attention has been paid to these factors. Estivation of a few adult specimens to perpetuate the species through periods of hot, dry weather is considered more probable, although in none of the island areas in which *Anopheles albimanus* is indigenous are climatological conditions such as clearly to establish the biological necessity for this phenomenon.

Bionomically, *Anopheles albimanus* possesses a number of characteristics which set it apart from many other anophelines. Some of these add greatly to difficulty of control and even more to that of eradication. The species is probably more closely similar to *Anopheles aquasalis* in its environmental responses than to any other species.

Aquatic Habitat—An. albimanus is popularly termed a universal breeder. It is found commonly in permanent and temporary breeding places, preferring the latter. Large water surfaces are not required; as many as 50 large larvae and pupae may be found in a single hoofprint. It breeds prolifically in fresh and brackish water; in fact production appears to be stimulated by salinity up to about 25% of sea water concentration. It appears able to tolerate a concentration of at least 50% of sea water salinity before production is terminated.[2, 3] While not found in swift currents, larvae and pupae are commonly present in prolific numbers along stream edges in still water pools of heel print size and up. Breeding in artificial containers is seldom a problem in controlling malaria transmitted by this species, but is a factor in eradication. Its ability to utilize the wide range of microflora and fauna found in fresh, salty and alkali waters in temporary to permanent situations also suggests tolerance to at least moderate pollution and turbidity. Pupae have been noted by the author in hoofprints constantly muddied by grazing cattle. Survival of fourth instar larvae and pupae in water grossly fouled with cattle urine also has been noted, although it is questionable whether development from ovum to imago takes place in such situations.

One ecologic factor exists however, which markedly inhibits production—*Anopheles albimanus* is heliophilic to such a degree that fully shaded situations are not of concern to the control worker. But its resourcefulness in utilizing favorable water surfaces approaching a micro-size means that shade must be continuous to insure the total absence of production.

The seasonal reduction in the abun-

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[2] Hurlbut, H. S. 1943. Observations on the Use of Sea Water in the Control of *Anopheles albimanus.* J. Parasitology, XXIX (5):356.

[3] Weathersbee, A. A. 1946. Malaria Control Activities During the Construction of an Advanced Tropical Naval Base. J. Nat. Mal. Soc. V(4):263.

dance of *Anopheles albimanus* which usually occurs in Puerto Rico during the period January through April or May can be utilized advantageously in the planning of eradicative operations.

At that time collections of imagoes in animal bait traps commonly fall to as little as 1 to 5% of those obtained for sustained periods within the remaining months of the year.[4] At some locations this reduction appears associated primarily with the relative dearth of temporary collections of water resulting from lack of rainfall, but the number of larvae found in more permanent waters also declines sharply. At times, reduced production in permanent waters seems partly due to lowered temperatures, but more obscure biological factors also appear to play a prominent role.

Conversely, both control and eradicative operations can be greatly impeded by the surges in production which occur in the less favorable months of the year. These adverse conditions are unavoidable in any program extending beyond the late winter-early spring season, as would be the case with island-wide eradication in Puerto Rico. Operational planning also is complicated by moderate variation in the pattern of scarcity and abundance for different parts of the island, and from year to year.

Flight Range.—Extremes of opinion as to the flight range of this species in sufficient numbers to constitute a malaria hazard, range from 1 to as much as 25 miles.[5] In Puerto Rico, the range is considered as from 1 to about 3½ miles. The length of this *effective flight* appears most prominently related to abundance of the species although other factors are acknowledged as significant. This more limited range is in closer agreement with general malariological opinion, although some might consider the figure of 3½ miles excessive.

The flight distance of the longest flying single individual female as an element in eradication can only be speculated on. In theory, this maximum flight as well as the effective flight mentioned above is in proportion to species abundance. Hence, the sparse populations prevailing after initial eradicative efforts may well hold both in check.

Zoophilism and Resting Places—An. albimanus may be classed on the zoophilic side in blood meal preference. In Puerto Rico several studies have been made to determine the comparative attractiveness of various animals, including man. The ratio of attractiveness of a small scrub horse to adult man has been found by one investigator (Weathersbee) [6] to be in the order of about 20:1. The calf is less attractive than the horse but more so than man.[7] Another related characteristic is its prejudice against man-made habitations as a day-time resting place. This may also tend to reduce the resting time within dwellings at night. Not only does virtually every remaining female leave between dawn and sunrise [8, 9] but many engorged specimens depart during the night even when no other buildings are nearby.[9]

Accordingly, the effectiveness of DDT residual house spray as an eradicative

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[4] Unpublished collection records. Malaria Control in War Areas, U. S. Public Health Service. 1942–46.

[5] Curry, D. P. 1943. Twenty-three Years Experience in Malaria Control in the Canal Zone. Proceedings, XXX Annual Meeting, N. J. Mosq. Ext. Assn. p. 60.

[6] Weathersbee, A. A. 1944. Observations on the Relative Attractiveness of Man and Horse for *Anopheles albimanus*. Am. J. Trop. Med. XXIV (1):25.

[7] Results of unpublished tests in Puerto Rico by Malaria Control in War Areas, U.S.P.H.S., 1942. Also observations by W. C. Earle and staff members of Bureau of Malaria Control, Dept. of Health of Puerto Rico, 1925–35. (Author's Note: These studies were made to determine baits for use in animal bait traps [stable traps] and to correlate these collections with the attractiveness of human populations. Restricted size of bait traps precludes the use of mature cattle and horses of large size.)

[8] Weathersbee, A. A. 1944. Observations on the Nocturnal Activity of Anopheles and Certain Other Mosquitoes in Eastern Puerto Rico. P.R.J. Pub. Hlth. & Trop. Med. XIX:626–34.

[9] Unpublished study, Malaria Control in War Areas, U.S.P.H.S., 1942.

measure can be adjudged as being far lower for *An. albimanus* than for other species which are androphilic, house-loving, or both. Major effectiveness can be anticipated only where human population is not only present but superior in mass attraction to competing animal blood meals. Such situations are encountered commonly in malaria control, but have minor significance in a terrain-wide program of eradicating this species. In this connection it is noted from studies by Trapido in Panama [10] that DDT residual spray applied to all dwellings in a village where there was little reported competition from domestic animals, did not influence collections from a stable trap 300 yards distant from the village area. Reduction was noted in a trap 100 yards from the village area, there being no intervening traps. Studies of DDT house spraying by Stephens and Pratt in Puerto Rico,[11, 12] conducted under different circumstances, showed no reduction in the adult population at large in a village area.

Most biologists, while aware that even slight reduction in the population of gravid females of an insect species means fewer eggs oviposited, vigorously oppose the reasoning that the rate of imaginal production is perceptibly affected by small reductions in the former. Hence, any adulticidal method which only slightly lowers the area-wide population of gravid females would appear valueless unless combined with other methods of adult mosquito control and a substantial accumulative effect obtained. For these reasons, the residual spraying of houses with DDT cannot be considered *per se* a significant weapon in eradicating this species over a large agricultural terrain such as that of Puerto Rico.

The search for other adulticidal methods which might effectively complement DDT residual house spraying in eradicating this species is made difficult by failure of the imago to congregate anywhere in the day-time. Little is known of its day-time resting places, but the search over many years has been assiduous and extensive enough to indicate that resting adults are dispersed. They have been seen scattered through the deep shade of some mangrove swamps, resting near the water line. But breeding places were nearby, and there is no evidence that the specimens had returned after leaving the breeding place. Until more definitive evidence is available, it can only be assumed that they rest under the cover of terrestrial as well as aquatic vegetation. The micro-climate offered by tall stands of mature sugar cane bordering small ditches and other water-courses must not differ greatly from that of water surfaces shaded by aquatic shrubs and plants. The dispersion of adults while at rest and the lack of knowledge as to their location preclude the present use of exterior space spraying in the day-time as an effective weapon in eradication. Their absence from habitations in the day-time similarly precludes the day-time use of interior space sprays. Furthermore, exterior space spraying at night in the manner practiced against *Aedes* species in New Jersey offers more promise of protecting a few clumps of blood meal sources than of becoming a major weapon in eradicating *An. albimanus*.

The residual spraying of cattle and other farm animals with aqueous suspensions of DDT or other insecticides however, offers promise in Puerto Rico of being surpassed in value only by larviciding. Where these animals are housed at night in barns and stables, the effectiveness of cattle spraying can be supplemented importantly by spraying the buildings. Agriculture is the principal means of support for Puerto Rico's population. On an area basis, the terrain in which *An. albimanus* is abundant consists largely of farm lands and adjoining swamps, marshes and water-courses. Moreover, the farm lands are

[10] Trapido, Harold. 1946. The Residual Spraying of Dwellings with DDT in the Control of Malaria Transmission in Panama, with Special Reference to *Anopheles albimanus*. Am. J. Trop. Med. XXVI (4):383.

[11] Stephens, P. A., and Pratt, H. D. 1947. Work with Residual DDT Spray in Puerto Rico. Science CV (2715):32.

[12] Pratt, H. D. 1947. Personal Communication.

mainly given over to the production of sugar cane or grazing. The draft oxen and the overseer's horse are symbolic of sugar cane culture. While Puerto Rico cannot be credited with a meat raising economy and the ratio of animal to human population is not high, the two live closely together and domestic animals are available to virtually the entire population of *An. albimanus* in Puerto Rico. In exceptional situations, such as the Island of Vieques, the population of farm animals approaches the human population in number.

(Part II of this article will appear in the September number.)

A NEW "JEEP" MOSQUITO CONTROL ASSEMBLY

Reported by T. D. Mulhern, Administrative Assistant,
New Jersey Agricultural Experiment Station.

A new "Jeep" spray outfit developed by Mr. L. D. McCarter, Supt., Hudson County Mosquito Extermination Commission (N. J.), may be of interest to other mosquito control workers.

The Hardie triplex pump alongside the driver is driven from the power take-off for ordinary spraying (600 lb. pressure). TIFA fog machine, shown on the "Jeep," is replaced by rectangular liquid spray supply tank when using Hardie pump. The Jeep is dual wheel equipped on rear axle, and trailer holds 40 army style 5 gal. cans.

LARGE-SCALE REARING OF *ANOPHELES QUADRIMACULATUS* SAY AT ORLANDO, FLORIDA[1]

MARGARET GREENWALD, J. H. COCHRAN, AND DONALD K. SCHARFF
U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine[2]

Insectary rearing of *Anopheles quadrimaculatus* Say was begun at the Orlando, Fla., laboratory of the Bureau of Entomology and Plant Quarantine in October 1942 to meet the demands for biological material for use in larvicide, repellent, and adulticide studies. The colony was established from eggs obtained through the courtesy of Mark F. Boyd, of the Rockefeller Foundation for Malaria Research at Tallahassee, Fla.

The first method for the insectary rearing of *Anopheles quadrimaculatus* was developed by Boyd *et al.* (1935) and the colony at Orlando represents a continuation of this strain. Crowell (1940) worked out a simple technique in which powdered dog biscuit was used as larval food. A technique similar to Crowell's was adapted to the Orlando rearing. Subsequent expansion of the colony entailed a gradual evolution of techniques and management.

At its peak the Orlando colony was producing an average daily output of approximately 40,000 adults, 5,000 larvae, and over 100,000 eggs. The following description of equipment and operations is for a colony of that capacity.

COLONY FACILITIES AND EQUIPMENT

The colony was housed in an old concrete-floored garage and occupied four rooms totaling 975 square feet of floor space. A cabinet 6 feet wide and 8 feet long was built in a corner of one of the rearing rooms to hold emergence cages. Outside doors and windows were screened. A general view of one of the rearing rooms is shown in Figure 1. In addition to this indoor unit, an outdoor unit containing 40 rearing boxes was maintained in a stream a few hundred feet below the spring at Rock Springs, Fla. (Eide 1945.)

Temperature, Humidity, and Light.—A temperature fluctuating between 78° and 90° F. provided satisfactory rearing conditions if neither extreme was maintained for more than a day at a time; 80° to 82° was about the best temperature for larval development. Thermostatically controlled electric or oil heaters, or a combination of the two, were used to maintain these temperatures during cool weather. The cabinet holding the emergence cages was equipped with an electric heater set to maintain a temperature of 84°, in order to keep emergence on a regular 2-day schedule and provide a steady supply of mosquitoes for experimental workers. Only one room was equipped with artificial cooling. The mosquito breeding cages were kept in this room, and egg production was maintained at a high level during the summer months.

Humidity control was unnecessary because of evaporation of water from the rearing vessels and the high natural humidity in Orlando.

The larvae avoided bright sunlight, and apparently daylight was not essential to their growth. The inside room housing the breeding cages and 160 rearing pans was lighted by fluorescent lights. The pupae production in this room compared favorably with that in other rooms.

Equipment.—In the indoor colony 600 pans and 54 shallow wooden boxes were used. For general purposes a white-enameled pan, 12 inches in diameter and 4½ inches deep, was the most satisfactory. Pans used for hatching and rearing were

[1] This work was conducted under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

[2] Acknowledgment is made to C. C. Deonier, under whose direction this work was done.

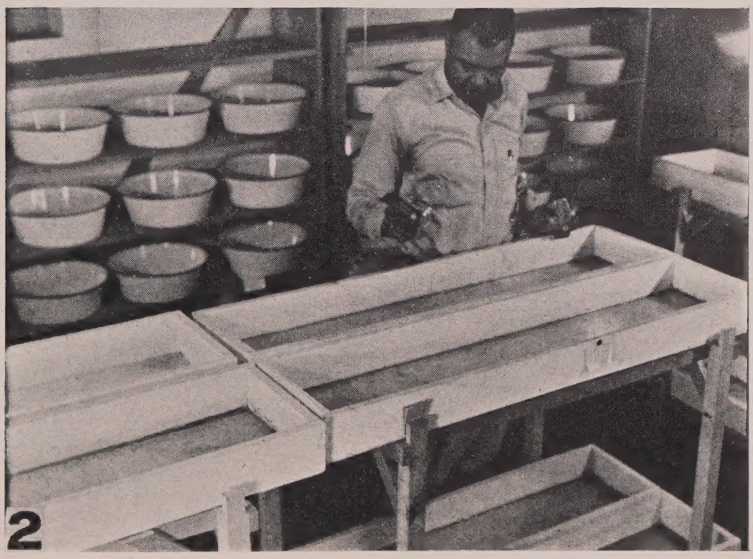
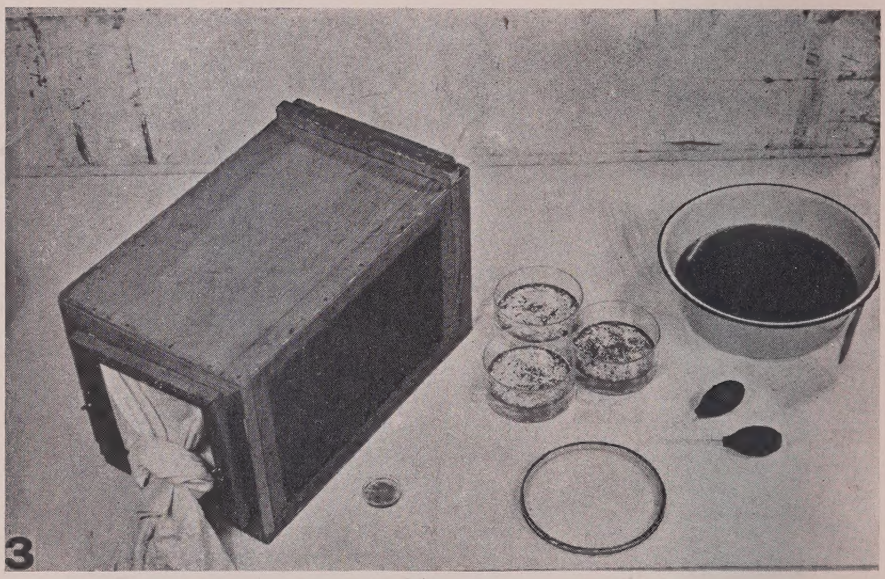


FIG. 1. One large rearing room showing arrangement of rearing pans and boxes, work table, and oil-burning heater. Note lighting over boxes. Worker at table picking pupae; worker in background feeding larvae. (Photo by R. Papen.)

FIG. 2. Feeding the larvae of *Anopheles quadrimaculatus* with dog food and yeast. Rearing troughs in foreground and rearing pans in background.



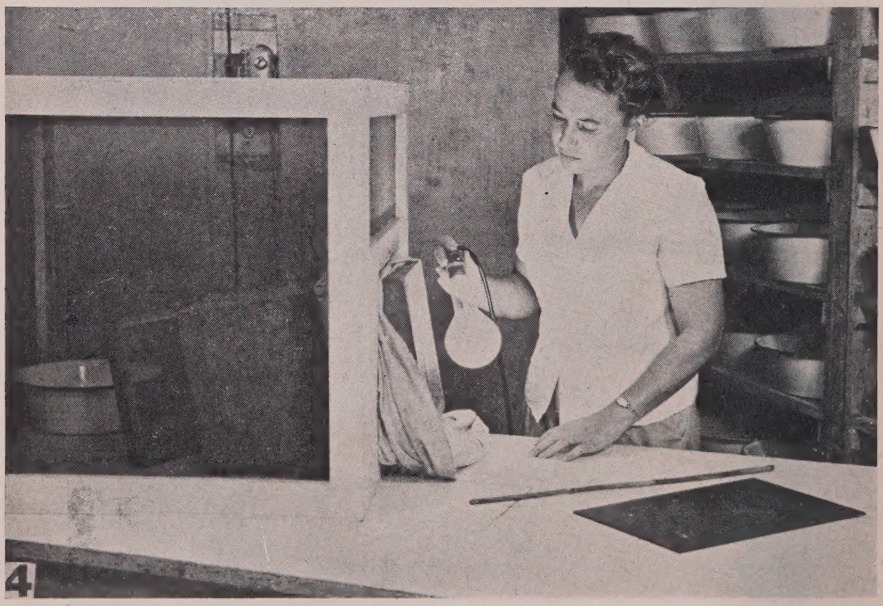


FIG. 3. Pupae and equipment for handling. Left to right: Emergence cage containing pupae, small petri dish of honey, 3 crystallization dishes containing 3,000 pupae, pupae strainer, pipettes for picking pupae, pan of pupae in dirty rearing water before being strained. (Photo by R. Papen.)

FIG. 4. Restocking a breeding cage. Cage contains oviposition pan, honey dish, and emergence cage from which mosquitoes are being driven by the light. Stick on table is used to open the door of the emergence cage inside the large cage; piece of board covered the hole in the bottom of the emergence cage until it was placed inside the large cage. Note that screen of large cage is inside the framing. (Photo by R. Papen.)

kept on level shelves 8½ inches apart, with the bottom shelf set a few inches above the floor.

The boxes were 1 foot wide, 5 feet long, and 3 inches deep. The sides were of 1-inch pine or cypress, and the bottoms of masonite or cypress. Each box was entirely covered with three coats of white-enamel marine paint. The boxes were set upon double-decked frames made of 2-inch lumber, being arranged singly or in pairs as the floor space permitted (Fig. 2), the lower boxes being 13 inches and the upper boxes 42 inches above the floor.

Most of the emergence cages used at Orlando were of the sleeve type pictured in Figure 3. They were 12 inches square by 18 inches long, with top and bottom of plywood, sides of 18-mesh window screen, and a door at the end opposite the sleeve.

The most desirable breeding cage was 30 inches square by 25 inches high, with sides of 18-mesh wire screen, and top and bottom of ¼-inch plywood (Fig. 4). The frame of the cage was constructed of 1- by 2-inch lumber, and quarter-round was used inside the corners to facilitate cleaning. The screen was on the inside of the frame. A front opening, 12 by 15 inches, was covered with a cloth sleeve 30 inches long. Larger cages were more difficult to clean and required more space.

All the rooms were equipped with work tables, running water, chairs, stools, etc. The extra equipment and glassware was stored on shelves within easy reach. All the work tables and the racks holding the emergence and breeding cages were ant-proofed.

Ten mature rabbits, caged separately, were kept for feeding the mosquitoes. Young rabbits were raised from time to time for replacement.

COLONY MANAGEMENT

Under favorable conditions a few mosquitoes developed from egg to adult in 10 days; however, others in the same lot required 2 weeks more to complete their cycle. If conditions were unfavorable, the developmental period sometimes extended over a full month, but under such circumstances a large proportion of the larvae died before pupating. The usual development and management of any given lot fell into the following time pattern:

1st day	Eggs
2nd to 4th day	Larvae in hatching pans
4th day	Transfer of larvae to rearing vessels
4th to 8th days	Larvae in rearing vessels
9th day	First pupae
9th to 15th days	Pupation period
11th to 17th days	Emergence
21st day	Oviposition

The usual daily tasks in the operation of the colony were as follows: (1) Taking up and setting eggs, (2) feeding larvae, (3) transferring young larvae from hatching pans to rearing vessels, (4) checking rearing vessels for water depth and larval populations, (5) removing pupae from rearing vessels, (6) transferring pupae from picking pans to emergence cages, (7) delivering mosquitoes to experimental workers, (8) replenishing mosquitoes in breeding cages, (9) placing rabbits in mosquito breeding cages for mosquitoes to feed upon, (10) feeding and watering rabbits and cleaning rabbitry, and (11) washing all empty rearing vessels and used glassware.

At less frequent intervals the breeding cages were cleaned, rabbits were clipped for mosquito feeding as needed, and eggs were packed for shipment to out-of-town workers.

Egg Production and Handling.—One white-enameled pan containing about an inch of water served as the oviposition pan in each breeding cage. The pans were removed from the breeding cages each morning. The eggs stranded on the side of a pan were washed down with a wash bottle, dead mosquitoes were removed, and eggs were concentrated by siphoning off the excess water. Eggs from all the oviposition pans were transferred to a glass beaker. Eggs for colony maintenance were set daily and the surplus was either stored in an ice box for future use or shipped

to other scientific workers who depended on the Orlando colony for their egg supply.

White-enameled rearing pans containing about an inch of tap water were used as hatching pans. The eggs were placed within a waxed cardboard ring, 3 to 4 inches outside diameter and ½ inch wide (Fig. 5), which floated on the water surface. The purpose of the ring was to prevent the eggs from becoming stranded on the sides of the pan. Three to five thousand eggs were sufficient for one hatching pan. The eggs were transferred with an oval loop made of fine wire, which enclosed an area of 72 sq. mm. and held about a thousand eggs in a double layer.

Eggs to be stored were spread in a thin layer on wet filter paper, placed in a moistened vial or small petri dish, covered, labeled with date and approximate number of eggs, and placed in an ice box. With this treatment they remained viable for 10 days. Eggs to be shipped were placed on wet filter paper and then between moistened cotton and paper pads in a paraffin-impregnated pill box. The boxes were wrapped with paper, taped, and sent by airmail special delivery in a regular letter envelope.

Handling of Larvae.—The newly hatched larvae were kept in the hatching pans until they were 3 days old. When hatching neared completion (usually 24 hours after the eggs were set), the larvae were given a sparse sprinkling of powdered yeast from a spice can. They were fed again when the surface film had been cleared away, that is, when the larvae skimmed lightly away when the surface film was blown gently. Another good indicator of whether food was needed was obtained by dropping a little yeast on the water surface; if the yeast spread quickly over the surface, food was needed. When the larvae were 2 days old, they generally took three feedings a day. Powdered dog biscuit was added to the diet after the second day. As the larvae grew, they required more food and the proportion of dog food to yeast was increased. Although Crowell (1940) had shown that a suitable dog food contained all the elements necessary for larval growth, yeast was included as a possible safeguard against the omission of some elements in the commercial product due to wartime conditions.[3] It was more satisfactory to keep a large number of newly hatched larvae concentrated in one pan during the first 3 days than to divide the eggs among the rearing dishes. The number of larvae per dish could be estimated better, and the danger of such formation, especially serious at this stage, was largely eliminated by the feeding of so many larvae.

The 3-day-old larvae were transferred to the rearing boxes and rearing pans (Fig. 2). The boxes were stocked with approximately 1,500 to 2,000 young larvae per square foot, and the pans with about 1,000 larvae each. All pans containing larvae of the same age were kept together on shelves, and were adjacent to the next older group. The pans were marked with the date the eggs were set.

Larvae were fed at 8, 11, 2, and 5 o'clock at first, and later it was found that three feedings a day (at 8, 11:30, and 4 o'clock) produced fine larvae and pupae. If larvae in any vessel were not ready for food on schedule, they were not fed until the next feeding time. Feeding required as much attention and judgment on the part of a worker as any other single task in the rearing work. Underfeeding of the young larvae resulted in stunting, or starvation, in which case dead larvae were floating in the rearing containers the next morning. Underfeeding of later instars resulted in cannibalism and uneven development among the larvae. Overfeeding also resulted in the stunting of young larvae by the formation of a surface scum to enmesh them, or in the death of larvae in a slime of excess feed on the bottom of the vessel. There were all gradations of these troubles, and it was often difficult to determine the cause. Larvae that were kept warm and well-fed developed uniformly through the

[3] Since 1946 powdered dog food alone has been employed, with entirely satisfactory results.

5

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FIG. 5. Eggs and equipment for handling. Left to right: Hatching pan with eggs set in the waxed ring, beaker of eggs and dead mosquitoes, waxed cardboard ring, wire loop for setting eggs, siphon (for removing excess water in beaker), wash bottle, and oviposition pan containing eggs and dead mosquitoes just as removed from the breeding cage. (Photo by R. Papen.)

FIG. 6. Rabbit frames and rabbits ready to go into the mosquito cages. Old-type frames at left, new stock-like frames at right. (Photo by R. Papen.)

third instar, after which some individuals grew faster and pupated earlier than others even with the most careful feeding.

It was necessary to add water daily to the rearing boxes and pans to replenish that lost from evaporation. The water was kept as shallow as possible so that the larvae could feed upon the bottom. It was not necessary to change the water during the growth of a group of larvae unless an excess of food caused fermentation.

Both powdered yeast and commercial dog-food checkers were used for food. The checkers were powdered by grinding and then sieved through a 40-mesh screen. The two foods were kept in separate spice cans and were dusted alternately onto the water. At the colony's peak of production approximately 2 pounds of dog food and 1 pound of yeast were used daily.

Handling of Pupae.—The pupae were picked from the rearing pans and boxes daily. With a large medicine dropper, or pipette, a good worker easily averaged 1,000 pupae per hour without injuring either pupae or larvae, or carrying many larvae over into the pupa dish. If any pupae were missed, they would probably emerge before the next day's picking, and cause mosquito annoyance in the rearing room.

Pupae picked from the rearing vessels were strained out by pouring the water through a piece of 18-mesh plastic screen clamped tautly between two 6-inch steel embroidery hoops. The strainer was quickly inverted and dipped into a pan containing fresh water to free the pupae. They were then poured from the pan into crystallization dishes and placed in emergence cages (Fig. 3). A 5-inch crystallization dish held about 1,000 pupae; other dishes were stocked in proportion to their surface area, and enough water was added to half-fill them.

From 3,000 to 4,000 pupae were placed in each cage for emergence. A small petri dish containing a disk of screen wire over some honey was supplied each cage. Two days were allowed for the mosquitoes to emerge. Pupa dishes and those containing honey were removed through the sleeve. Jarring the dishes and blowing on their surface prevented adults from escaping.

The adults as they emerged were either used in repellent and insecticide tests, or added to the breeding stock.

Handling of Breeding Stock.—Initial stocking of a breeding cage with about 5,000 mosquitoes and subsequent replenishment at weekly intervals with 2,000 adults gave an average daily egg production of 15,000 to 20,000 eggs. Six of these cages were maintained to supply the eggs for the colony's needs and requests from workers. Figure 4 shows a cage being restocked.

The first eggs were laid the fourth day after the initial stocking and feeding of the females on a blood meal obtained from a shaved rabbit. Full production was reached by the end of the first week. Each weekday one breeding cage had approximately 2,000 mosquitoes added to its population and by this arrangement it was possible to keep the egg supply fairly uniform and at the same time avoid using too many mosquitoes from 1 day's crop. Each breeding cage was provided with undiluted honey, water, and an oviposition pan; and once daily, except on Sundays and holidays, a rabbit was put in for 1 to 2 hours. The racks used to hold the rabbits (Fig. 6) were patterned from a holder designed by Laug (1944). A constant supply of water was required, and its omission from the cages for more than a day in warm weather resulted in as much as 90% mortality. The mosquitoes required protection from ants and spiders, and from winds, strong lights, and extremes in temperature.

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NOTES ON A *MANSONIA PERTURBANS* PROBLEM AT EDGEWOOD ARSENAL, MARYLAND

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Edgewood Arsenal is a Chemical Corps installation situated on the west shore of Chesapeake Bay. The populated portion of the reservation occupies the base of a peninsula, named Gunpowder Neck which is approximately eight miles long, and is bounded on the east by Bush River and small tributaries, on the west by Gunpowder River, and on the south by Chesapeake Bay. Approximately four miles wide at its base in the north, Gunpowder Neck tapers more or less gradually to its extreme tip. Only the basal portion is populated.

The entire peninsula is low, almost all of the surface standing at less than thirty feet above sea level. There are numerous tidal marshes along both rivers, some of which are inundated with each high tide, while others may be covered with water only a few times in the period of a month. Many fit into both of these categories, some portions of a given marsh being subject to daily tidal action, others being covered only at extremely high tides. The channels through the marshes are in many cases ill-defined and inadequate for drainage during low tide, resulting in large areas of stagnant water amidst typical aquatic vegetation, the commonest forms being *Typha, Pontederia, Sagittaria,* and numerous species of rushes, sedges, and grasses. More than 800 acres of such marsh are situated in the northern, populated, portion of the reservation.

Early in the season of 1946, it was decided that the Arsenal would be one of the twelve posts chosen for treatment with DDT from the air. The program of DDT dispersal from aircraft in the Zone of the Interior was still in the process of evaluation, and was a project of the War Department, with the Corps of Engineers, Army Air Forces, and Army Medical Department cooperating.[1] One of the chief reasons for the choice of Edgewood Arsenal was a rather high density of *Anopheles quadrimaculatus* (the malaria vector for Eastern United States) reported from light trap collections in 1945, and the high density of pest mosquitoes.

Careful study of data from previous years was necessary to determine the date for the plane-spraying from which the post might derive the greatest benefit, for there was a history of serious pest-species abundance to consider, secondary to the problem of reduction of disease vectors. Moreover, it was necessary to select this date far in advance of the actual application of spray. Past records revealed that *Culex* spp. had been present in large numbers, and that *Aedes vexans* and *Mansonia perturbans* had been common, although not by any means predominant, species. Salt marsh mosquitoes had not been encountered in any serious numbers. As a result of this study, it was decided to apply the spray on July 16, 1946, with a second application about one month later, if necessary.

The area chosen for the project consisted of approximately 3500 acres in two sectors: first, all of the peninsula south of the populated area for a distance of two miles; second, a much smaller similar peninsula to the northeast of Gunpowder Neck. It was planned that normal ground control measures would cover the populated northern area (the 800-odd acres of marsh could be covered by plane in connection with experimental work on DDT dispersal from aircraft, being carried

* The writer wishes to acknowledge the assistance of Mr. S. S. Easter, who helped greatly in various phases of the work.

[1] An evaluation of the over-all program has been published by the National Research Council under the title "Abstract of Report of Aerial Spray Operations in the Continental United States in 1946." April 1, 1947.

on at the post),[2] the two rivers to the east and west would form barriers averaging more than one mile in width, while the project already described would cover sources of infiltration from the south and the small neck in the northeast. It was not practical to include the private property beyond the northern boundary, but there was no breeding place of any consequence to the north for a considerable distance from the boundary.

The plan was not successful. *Mansonia perturbans* appeared in numbers during the third week in June. Of a total light trap collection of 4731 mosquitoes for the eight-day period from July 3–10, from six widely dispersed traps, 89% were *M. perturbans*. The river "barriers" were ineffective against a species with such strong flight habits; the distant marshes beyond the northern boundary became a source of constant influx; and the set date for the larger-scale airplane operation was unfortunately far in the future (although from a malaria control standpoint there was no reason to attempt any change). One biting collection, on July 2, near the center of the populated area of the post, produced specimens at a rate of 83 in five minutes (996 per hour), of which 81 were *M. perturbans*.

It was obvious either that the population of this species had been unusually small in the two preceding years (the only ones for which data were available), or that the 1946 season was producing a bumper crop.

Mansonia perturbans has a single generation each year. The eggs are laid in floating rafts during the summer. The larvae overwinter. Pupation occurs in summer and the adults emerge thereafter, the greatest emergence apparently taking place in early summer. The larvae possess a breathing tube but are said not to come to the surface for air as do other culicine larvae. Instead, the breathing tube is inserted into the stem of an aquatic plant beneath the surface of the water and air is obtained through the stem. Thus, conventional larviciding procedures are ineffective against this species, although much remains to be learned of the potentialities of DDT in this respect. The adults bite fiercely during a short period in the evening, making it necessary to obtain biting records within a very limited time interval to gain an accurate idea of the population. The biting collection already referred to was taken at the beginning of the flight period. So precise were the habits of these mosquitoes that, weather conditions remaining approximately the same, it was possible to predict within five minutes when heavy biting would begin, from observations of a previous evening. The length of the biting period was more variable, but generally speaking, an enormous difference in the data obtained at any given biting station resulted from a time lapse of twenty minutes after the onset of heavy biting.

Using the local equipment and 5% DDT in diesel oil #2, 3850 acres of the populated portion of the post were treated in eight flights, an average of slightly more than 480 acres per flight. Limitations of materials and the necessity of securing technical data on performance made larger scale operations impossible. Areas were selected in view of population densities as established by biting records and light trap collections. In general, an estimated 0.3 pound of DDT per acre was used in these tests. Results were gratifying, but of short duration. At the biting station mentioned above (rate before treatment 996 per hour), the biting rate was immediately reduced by 88%, and five days later the reduction was 78% of the original figure. But this was unusual. Another biting station in another test area showed a 100% reduction in twenty-four hours, but the rate nine days later was 163% of the original rate. In another area, immediate reduction by 45% was followed by an increase to 164%. It is realized, of course, that biting collections are liable to considerable error, and these figures are cited merely to demonstrate a trend. Unfortunately no data were obtained on the

[2] Details of this development are to be included in a report (TDMR) of the Chemical Corps at a future date.

emergence of adults. "Control" biting station records yielded invalid data because of the extreme periodicity of the biting habits of this species, and the lack of qualified personnel, at that time, to take records simultaneously in two separate areas. By the time a "control" area was reached, after having taken a biting collection in a sprayed area, the flight period was past, or nearly so.

Reasons for the rapid build-up in population after the immediate reduction are matters for speculation. Obviously the population might be restored by influx from neighboring untreated areas, as well as by new emergences of adults. Figures obtained in later operations in untreated control areas indicate a possibility that a constant and more rapid increase in population might have occurred, without treatment, and that the treatment was thus beneficial, even though the results were of short duration. Reduction in the number of natural enemies seems of little consequence in view of surveys which were made by the Fish and Wildlife Service at a later date.

In all of the airplane spraying described above, the area of the peninsula south of the populated area was practically untouched, to prevent introduction of imponderables to the conditions of the larger airplane-spraying operation to come, and none of these smaller operations took place in the two-week period preceding July 16.

On July 16, as scheduled, treatment of the 3500 acres already described took place. Using a 20% solution of DDT in a special solvent, the application was approximately 0.20 pound of DDT per acre. The plane was a C-47 equipped with a 675-gallon capacity belly tank with a 7/8 inch diameter discharge pipe which could be opened and closed by the pilot. The swath intervals were 100 yards and were marked on the ground by smoke grenades.

Data on this operation, from light trap records are set forth below. Traps 1 and 5 were located at such a distance from the sprayed areas that they fulfilled most requirements for "controls." The number of days, which is variable in these data, represents no selection by the writer—the dates include all those for which determinations were made by army laboratories.

The "after" records, in no instance, were taken more than six days after the spray was applied. Later catches were not determined to species, so that totals for all species are all that are available. These show that, until August 13, there was a gradual increase in population. The population by that date had not attained the pre-spray level, the total catch for all traps for the week ending on August 13 being only 23.3% of the total catch for the week ending July 15, the day before the spraying.

Numerous biting records made on the day before, and during the week after the large-scale spraying operation of July 16 present a picture similar to that presented by the light traps—with a similar unexpected effect on some "control" stations.

Conclusions concerning the effectiveness of DDT, applied as described above, as a measure against *M. perturbans* are to be drawn with caution. As previously noted, in the case of small areas treated from the air, reduction in population was swift and spectacular, but of short duration, the sort of result one might expect in the case of an "adulticide" used against a strong-flying species. No data were obtained on larvicidal action, if any, and none were obtained on emergence rates, a factor which should be of considerable

AVERAGE DAILY CATCH OF *M. PERTURBANS*

	Before spraying	*After spraying*
Trap #1 (nine days)	54.55	48.60 (five days)
Trap #2 (eight days)	223.63	9.50 (six days)
Trap #3 (nine days)	133.00	2.85 (six days)
Trap #4 (four days)	361.75	3.67 (three days)
Trap #5 (eight days)	49.63	15.17 (six days)
Trap #6 (nine days)	22.00	1.67 (three days)

importance in the reestablishment of a heavy population following an application of spray.

In the larger operation of July 16, the reduction was pronounced and longer-lived. Such a result, of course, would occur if neighboring sources of infiltration were treated, as was the case. However, it must not be concluded that such a result would prevail under different conditions. It is very probable that the peak of emergence of *M. perturbans* had occurred before July 16. If the date of the larger spraying operation had been prior to the peak of emergence, it is reasonable to entertain the possibility that the results would have been less gratifying from the standpoint of duration.

FIG. 1. Outlook from mouth of Watson's Creek showing typical *Mansonia* breeding ground.

STUDIES ON THE FLIGHT RANGE OF CERTAIN *CULEX* MOSQUITOES, USING A FLUORESCENT-DYE MARKER, WITH NOTES ON *CULISETA* AND *ANOPHELES*[1]

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The problem of the flight range of *Anopheles* mosquitoes has been investigated rather extensively because of their known relationship to malaria. These studies have been well summarized recently by Eyles.[1] However, few reports are to be found which concern the flight range of the culicine mosquitoes, and we are acquainted with but one having to do with *Culex* (Clarke[2]). Certain species of *Culex* now are known to serve as vectors of some of the important virus encephalitides of man and horse, in addition to their well-known role as carriers of human filariasis and the avian malarias. Furthermore, their importance as pests cannot be minimized.

With the increased appreciation of the public health significance of *Culex* mosquitoes and with the beginning in California of extensive control programs directed particularly against *Culex tarsalis* Coquillett, it became necessary to acquire knowledge of the distances traveled by some of the commoner species of this genus in California. The studies herein reported were carried out during the summers of 1946 and 1947 in Kern County, California, an area in which the Western equine and St. Louis types of encephalitis are endemic. This same area has been a center for other epidemiological studies of these and other related infections by the Hooper Foundation, Neurotropic Virus Research Unit.

Methods

A review of the literature convinced us that none of the methods in common use for marking, and later identifying the same marked specimens among collections, was quite suited to our over-all field research problem. If the large numbers of mosquitoes collected in the flight-range studies could also be subjected to tests for the presence of viruses or to dissection to determine sporozoite and oocyst rates in avian malaria surveys, we could accomplish more from the use of a limited group of trained field collectors. The use of aniline dyes, commonly employed by other investigators, required the moistening of specimens with a solvent such as alcohol or acetone, thus rendering the specimens useless for other studies. It was felt that the use of the alternative, metallic dusts, would necessitate such elaborate precautions in preventing contamination of clothing and laboratory equipment as to render field operations highly unwieldy. It was also recognized that the type of meticulous examination required for identifying specimens so marked was very time consuming. Therefore, a marker with the following characteristics was sought: (1) small amounts would be visible without the use of a solvent; (2) it could be handled easily with a minimum chance of contamination of equipment, contact with which might contaminate unmarked mosquitoes; and (3) close microscopic examination of individual specimens would not be required for its detection. The fluorescent dyes seemed best to fit the above characteristics.

[1] This investigation was carried out in collaboration with the Communicable Disease Center, U.S.P.H.S.; and the Commission on Virus and Rickettsial Diseases, Army Epidemiological Board, Office of the Surgeon General, U. S. Army, Washington, D. C.; and under a contract with the California State Department of Public Health.

[2] Assigned to the George Williams Hooper Foundation through the California State Department of Public Health by the Communicable Disease Center, U.S.P.H.S.

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Beginning in San Francisco in May 1945 the following dyes were tested: * rhodamine, anthracene, fluorescein, uranium salts, uranin, riboflavine and fluorescent purple. Before the findings of these laboratory studies could be applied to field tests, Zukel [3] reported the findings of laboratory studies of a somewhat similar nature. Following this Cnang [4] published a report on laboratory studies of fluorescent materials as markers for mosquitoes. However, the above authors did not point out that fluorescent particles frequently are to be found on field-caught mosquitoes, and occasionally even on laboratory-reared specimens. In examinations under ultra-violet radiation of over 78,000 freshly killed field-collected mosquitoes in Kern County, numerous specimens have been observed to have minute fluorescent blue, purple, green, white, yellow or orange particles on their bodies. However, we did not observe on these mosquitoes any naturally occurring red-fluorescent materials. Therefore, rhodamine-B (National Aniline Division, Allied Chemical and Dye Corporation), a water-soluble dye producing red fluorescence under ultra-violet light was finally selected for use in all of the field studies herein reported.

In the laboratory, attempts to obtain adequately marked adults from larvae reared in 1:1,000 to 1:10,000 solutions of rhodamine-B in water were unsuccessful, either because of high mortality among larvae or of failure of the dye to carry over into the adult stage. Similar unsatisfactory results were reported by Chang.[4]

It was found, however, that 25 to 50% of adults feed readily on 1:1,000 to 1:10,000 solutions of rhodamine-B in sugar water. No toxic effects were noted on comparison with controls fed on sugar water alone. Adults which had fed on such a solution retained a characteristic carmine-red coloration of the abdomen readily visible in ordinary light. When irradiated with the dark light, a brilliant red fluorescence was observed. The female mosquito retained this fluorescence for at least 7 days in the laboratory, even following a blood meal and the subsequent formation of eggs. It also has been noted that the dye is still visible after death of the mosquito for at least 19 days. Although in field tests, several recoveries were made of mosquitoes which had fed thus on the dye solution, this method is not too well suited to flight range studies, principally because of the difficulty in getting a large proportion of specimens to feed on the solution. However, it would appear that this method does offer certain advantages for use in tagging mosquitoes for other biological studies, since there is a minimal chance of damaging specimens or of contaminating unmarked ones.

The application of fluorescent dyes to the bodies of mosquitoes as dusts has been found to be the method of choice. Zukel's [3] method of preparing and applying the fluorescent materials was used. Briefly, this consists of mixing one part of the dye with 6 parts of gum arabic, adding water until the mixture is of a pasty consistency, allowing this to dry, and then grinding it to a fine powder in a mortar. The powder is applied to adult mosquitoes in the holding cage, by means of a hand-operated powder blower (DeVilbiss, #118), after which the humidity in the cage is raised nearly to saturation. The dye-gum arabic particles, absorbing moisture, adhere readily to the mosquitoes' bodies, and apparently are not lost after drying. The minimum amount of dust necessary to clearly mark the mosquitoes should be used. An excess will result in increased mortality and decrease in flight power. To determine the proper amount requires some preliminary experience.

All mosquitoes used in the flight-range experiments were reared in the laboratory from field-collected larvae and pupae. During the first year's study, adults, as they emerged, were transferred by means of a sucking tube from the emergence cages to a wooden, screen-topped, holding and

* We are greatly indebted to Dr. Louis A. Strait, of the University of California Medical Center, for valuable advice and assistance in selecting these dyes and a proper source of ultra violet light of suitable wave length.

release cage. At this time they were counted. Since pure cultures of any one species of mosquitoes ordinarily were not available, a sample of adults from the emergence cages was identified. By this means the approximate number of each species was estimated. During the entire holding period the adults were offered solutions of rhodamine-B in sugar water on cotton pads. Within 48 hours after emergence, the adults were transported to the point of release in the holding cage, which was wrapped in wet burlap sacks in order to maintain a humid atmosphere. In spite of all precautions, however, it was found that the mortality of mosquitoes in the holding cage was about 25%. Ten minutes before release the mosquitoes were dusted with the gum arabic-dye particles.

Several modifications were made in the procedure for the second year's studies. Larval and pupal stages of mosquitoes, principally of the species *Culex tarsalis* but including small numbers of *Culiseta incidens* Thomson and *Anopheles pseudopunctipennis franciscanus* MacCracken were collected simultaneously in a prolific breeding area. The proportion of each species was determined by the identification of samples of larvae and adults from the cultures. These were held in the laboratory in white enamel pans. As the pupae appeared they were transferred in accurately counted lots of approximately 500 into 50-pound shortening cans which had been modified by replacing the centers of the covers with bobbinet and by brazing short copper tubes into the bases of the cans as water outlets (Fig. 1). Adults were permitted to emerge in these cans and were offered a solution of rhodamine-B and sugar as food. Specimens were held in the cans for from 3 to 7 days before release. It was found that the mortality in pupae and adults amounted to less than 5%, probably because of the relatively small numbers of insects for the available space and also because a high humidity was maintained. In preparing for the release of the mosquitoes, the water in the bottom of the rearing cans was drained. The dead or live pupae remaining in the water at this time were counted to determine the actual number of adults emerged. Following this, the rhodamine-B gum arabic dust was introduced in the same manner as previously described and wet towels were placed over the top of the can to maintain a high humidity. Then, the cans were transported from the laboratory to the release point, a distance of about 20 miles. After release all adults remaining in the cans were identified, counted and checked for presence of the fluorescent marker.

The center of the experimental area was selected as the release point.

For recoveries mosquities were collected from preselected stations by means of sucking tubes. Those from each collecting station were placed in separate small carrying cages. As far as possible, collections were made in all directions from the release point at distances varying from 0.2 miles up to 3 miles. Upon return to the laboratory the mosquitoes were lightly chloroformed, and examined immediately in a dark-room under a low power dissecting microscope for the presence of rhodamine particles. For a source of ultra violet light an H4 Mercury lamp (Keese Engineering Company, Shannon No. 92-LS) equipped with two Corning heat resisting glass filters, a blue and a red-purple, was used. This lamp produced light with an average wave length of 3400 Å and a range of 3100 to 4000 Å. Detailed examination and handling of individual specimens was not necessary. The rhodamine particles adhering to marked mosquitoes were readily visible as brilliant red pin points of light. Marked specimens were separated and identified. Using this technique it was possible to examine over 1,000 specimens per hour. The short period of exposure to this intensity and wave length of ultra violet apparently does not inactivate virus in the mosquitoes for numerous virus isolations were made in both 1946 and 1947 from mosquitoes which had been examined for fluorescence in flight range studies.

The 28 square-mile experimental area is level and consists of farmyards and

cultivated fields. No communities are included in the area. The principal crops are cotton, potatoes, tomatoes, alfalfa, cereals and deciduous fruits, chiefly peaches. All crops are constantly irrigated during the summer months, and normally there are present large numbers of the mosquito species included in this study. The area is characterized by high summer temperatures and low relative humidities. During the time of these studies daily maximum temperature ranged from 81° to 105° F. and relative humidity ranged from 8–73% with the mean below 40%.

The entire area had been carefully mapped during preceding years for other studies, and complete records of the distribution of buildings were available. Also, the preferred adult mosquito resting places were well known. The collection stations were determined by the occurrence of preferred resting places for adult *Culex*. All stations were man-made shelters, such as: porches, chicken houses, pump houses, out-door privies and garages.

1946 STUDY AND RESULTS

From May 20 to June 28, 1946, five releases were made totaling approximately 47,700 mosquitoes belonging to the species *Culex tarsalis, Culex stigmatosoma* Dyar and *Culex quinquefasciatus* Say, with approximately equal ratios of males to females. These releases were all made between the hours of 5 and 7 p.m. Between May 21 and July 2, collections were made on 13 days in an attempt to recover marked specimens. The distances at which all recaptures were made are summarized in Table 1.

A total of 11,800 marked *Culex tarsalis* were released. Of 14,873 specimens of this species collected after the releases only 5 marked females were recaptured. Two of these were taken at a distance of 0.5 mile and 3 at 0.2 mile from the point of release (Fig. 2).

About 7,500 marked *Culex stigmatosoma* were released, and 3,048 specimens of this species collected subsequently. Ten marked specimens were recaptured: 6 females and 3 males at 0.2 mile, and 1 female at 1 mile from the release point.

Of approximately 26,700 *Culex quinquefasciatus* released and 18,244 specimens collected, 58 marked specimens were recovered. The distances at which recaptures were made are summarized in Table 2. Twenty females and 27 males

TABLE 2. Summary of Recoveries of Marked *Culex quinquefasciatus*, 1946

Distance in miles from release point	Females recovered	Males recovered
0.2	20	27
0.5	2	1
0.75	2	0
1.0	3	2
2.5	1	0
Totals	28	30

were recovered at 0.2 mile, 2 females and 1 male at 0.5 mile, and the maximum distance at which a recovery was made was 1 female at 2.5 miles.

Although detailed records of direction and intensity of air movement are not available for the period during which the studies were made, it was noted at the release point that in the early evening there was usually a light to heavy northwest breeze which died down by 10:00 p.m. United States Weather Bureau reports from Bakersfield, about 20 miles south of the study area, recorded a prevailing air movement from the northwest with daily maximum velocities ranging from 13 to 31 miles per hour during the study period. The two releases of *Culex quinquefasciatus* were made on relatively quiet evenings. Two releases of *Culex tarsalis* and *Culex stigmatosoma* were made on evenings when a strong northwest breeze was blowing; the third was made on a quiet evening. Only 13 of the 73 recoveries were made to the north or west of the release point. The greatest distance at which recoveries were made in the direction against the prevailing wind were as follows: *C. quinquefasciatus*, 2 females at 1 mile and 2 males at ¼ mile; *C. tarsalis*, 2 females at ½ mile.

Table 1. Summary of Marked Mosquitoes Released and Specimens Recovered in 1946

Date of Release	Species Released	Approx. No. Released	Date of Collection	Total No. of Mosquitoes Collected	Marked Specimens Collected		
					Species	Number	Distance Travelled
			5–21	432	C. tarsalis	1	0.2 mi.
					C. stigmatosoma	1	0.2 mi.
			5–22	584	C. stigmatosoma	2	0.2 mi.
5–20	C. tarsalis	2,800	5–23	274	C. stigmatosoma	1	0.2 mi.
	C. stigmatosoma	5,800			C. stigmatosoma	1	1.0 mi.
			5–24	943	C. stigmatosoma	1	0.2 mi.
					C. tarsalis	1	0.5 mi.
			5–28	815	C. tarsalis	1	0.2 mi.
					C. stigmatosoma	4	0.2 mi.
					C. tarsalis	1	0.5 mi.
6–11	C. tarsalis						
	C. stigmatosoma	3,400	6–12	1,976	C. quinquefasciatus	1	0.2 mi.
	C. quinquefasciatus	1,200			C. quinquefasciatus	1	1.0 mi.
				2,153	C. quinquefasciatus	6	0.2 mi.
6–13	C. quinquefasciatus	6,500	6–14		C. quinquefasciatus	1	0.2 mi.
					C. quinquefasciatus	1	0.5 mi.
			6–18	3,964	C. quinquefasciatus	11	0.2 mi.
					C. quinquefasciatus	6	0.2 mi.
					C. quinquefasciatus	3	1.0 mi.
					C. quinquefasciatus	1	1.0 mi.
					C. quinquefasciatus	1	0.5 mi.
					C. quinquefasciatus	1	0.75 mi.
6–18	C. quinquefasciatus	19,000			C. quinquefasciatus	1	0.5 mi.
			6–19	4,165	C. quinquefasciatus	11	0.2 mi.
					C. quinquefasciatus	1	1.0 mi.
					C. quinquefasciatus	1	2.5 mi.
			6–20	5,968	C. quinquefasciatus	9	0.2 mi.
					C. quinquefasciatus	2	0.2 mi.
			6–29	2,490	C. tarsalis	1	0.2 mi.
6–28	C. tarsalis	9,000	7–1	5,616	no recoveries		
			7–2	3,719	no recoveries		

1947 Study and Results

This study was conducted between June 15 and July 23, 1947. During this period a total of 23,021 mosquitoes consisting of 93.6% *Culex tarsalis*, 4.5% *Anopheles pseudopunctipennis franciscanus* and 1.9% *Culiseta incidens* were released on 8 different occasions (Table 3). Approximately equal ratios of males and females of each species were included in the releases. Collections were made on each of

Table 3. Number of Mosquitoes Released in Each Week of the 1947 Study

Week	Total Specimens Released
June 15–21 *	3,611
June 22–28	4,522
June 29–July 5	4,675
July 6–12 *	6,251
July 13–19	3,962
Total	23,021

* Two releases made this week.

26 days, and a total of 42,783 mosquitoes of all species were collected in an attempt to recover marked specimens. Thirty-two marked mosquitoes were recovered. These included 18 female and 10 male *C. tarsalis* (Table 4 and Fig. 1), 2 female and 1 male were partially engorged and gravid, and 2 were freshly engorged.

DISCUSSION AND INTERPRETATION OF DATA

In these studies it soon became obvious that the number of marked specimens re-

TABLE 4. Summary of Mosquito Collections Made in 1947 for Recovery of Marked Specimens: Results for *Culex tarsalis* Only

Study Ring	No. sq. mi.	No. collecting stations	No. collections made	No. mosquitoes all species collected	No. C. tarsalis collected			No. marked C. tarsalis recovered		
					F	M	Total	F	M	Total
0–½ mi.	.8	6	32	2623	667	255	922	7	6	13
½–1 mi.	2.4	16	126	13906	2316	900	3216	9	3	12
1–1½ mi.	3.9	22	205	17183	1868	540	2408	1	1	2
1½–2 mi.	5.5	9	40	2255	137	21	158	0	0	0
2–3 mi.	15.7	6	64	7042	923	133	1056	1	0	1
Total	28.3	59	467	43009	5911	1849	7660	18	10	28

A. pseudopunctipennis, and 1 male *Culiseta incidens.* The maximum range at which these species were recovered was: *C. tarsalis* female 2.5 miles, male 1.1 miles; *A. pseudopunctipennis* female 0.9 mile, male 0.9 mile; and *C. incidens* male 0.6 mile.

As in 1946 detailed records of direction and intensity of air movements are not available for the study area. United States Weather Bureau reports from Bakersfield recorded a prevailing northwest wind during the study period with daily maximum velocities ranging from 12 to 29 miles per hour. Of the 8 releases two were made on quiet evenings, 3 during gusty intermittent breezes, 2 during strong breezes, and for one, observations regarding the wind were not recorded.

The majority of the recoveries of marked *Culex tarsalis* (22 of 28) were made to the north or west of the release point (Fig. 1). The opposite was true in 1946 when only a small proportion of all recoveries (13 of 73) were made upwind.

It is interesting to note that 7 of 18 *Culex tarsalis* females recovered had succeeded in obtaining a blood meal subsequent to their release; 3 were gravid, 2 leased represented but a very small part of the relatively enormous mosquito population naturally present in the 28 square miles of the study area, and that with the personnel available and territory to be covered, the number of recoveries would be relatively small. In 1946, of approximately 47,000 marked mosquitoes released, only 73 were recovered, or less than one out of 650 released; and in 1947 only one mosquito was recovered out of 720 released.

In Table 5 the collection data for 1947 have been presented on the basis of samples

FIG. 1. Mosquito rearing cans used in 1947 study.

TABLE 5. Average Collection Figures per Square Mile of Study Area 1947

Study Ring	No. sq. mi.	Average No. stations per sq. mi	Average No. collections per sq. mi.	Average No. mosquitoes collected per sq. mi.	Average No. *C. tarsalis* collected			Recoveries marked *C. tarsalis* sq. mi
					F	M	Total	
0–½ mi.	0.8	7.5	40.0	3279	834	331	1165	16.25
½–1 mi.	2.4	7.5	52.5	5794	965	375	1340	5.0
1–1½ mi.	3.9	5.6	52.6	4406	479	138	617	0.50
1½–2 mi.	5.5	1.6	7.3	410	25	4	29	0.0
2–3 mi.	15.7	0.4	4.1	451	59	9	68	0.06
Total	28.3	2.1	16.5	1520	209	65	271	0.99

and recoveries per square mile of study area. The authors do not feel that these data should be submitted to extensive statistical analysis. The numbers of recoveries made were too small to suggest their use for derivation of estimates of the natural mosquito populations in the experimental area as was carried out by Eyles and Cox [5] with *Anopheles quadrimaculatus* Say; or analysis of flight distribution patterns as was carried out by Russell *et al.*[6] with *Anopheles culicifacies* Giles; Gilmour *et al.* with blowflies [7]; or Jackson [8] with tsetse flies. The above authors found large standard errors in their data and encountered many difficulties in interpretation even though their numbers of specimens released, and numbers recovered were much larger than those in the present study; and their methods of sampling were much better standardized than was possible in the present study.

The present studies were not designed to determine maximum range of flight, but rather were designed to estimate what Russell *et al.*[6] have termed "the effective flight range." * The bulk of the recoveries were made within a mile of the release point. However, even with limited sampling beyond one mile, one recovery each of *Culex tarsalis* and *Culex quinquefasciatus* was made at 2½ miles distance from the release point. We cannot say that these species will not travel longer distances. It can be seen even from these relatively limited studies that an extensive breeding ground of *C. tarsalis, C. quinquefasciatus* and possibly *C. stigmatosoma* although located a mile or more outside of the boundaries of a mosquito control district or municipality could serve as an important source of infestation. Thus we can not consider infestations with these species solely as a backyard or neighborhood problem with regard to either their pest or disease vector activity. As a result of the findings of this survey, although the data are admittedly inadequate, we feel that as a tentative practical limit for control measures they should be carried out in a zone not less than one and one-half miles beyond the human or equine hosts to be protected. It could very well be that under different conditions of temperature, humidity, wind or topography this species would have a longer life or an inclination to travel longer distances. If this is demonstrated by future studies the above recommendations will have to be revised.

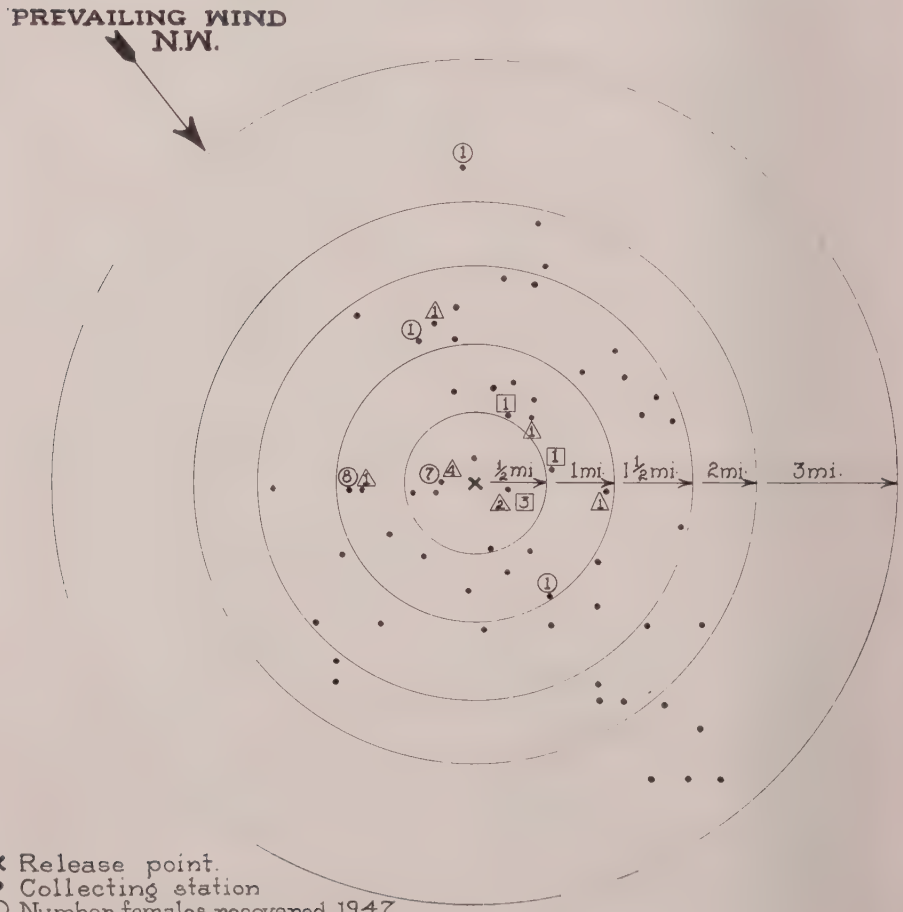
The fact that recoveries of *Anopheles pseudopunctipennis franciscanus,* and *Culiseta incidens* were made up to 0.9 and 0.6 mile respectively means that these

* The effective flight range of a species being the maximum distance from its breeding places that a species normally is able to fly in effective numbers. By effective numbers these authors meant in numbers sufficient to propagate a mosquito borne disease or to constitute a mosquito nuisance.

species will travel at least that far, and it may be that they will travel further. The information obtained on these was incidental to the main study, and they were included only because of the impracticability of separating the immature stages from those of *C. tarsalis* at the time of rearing for marking and release.

The new technique of marking mosquitoes with a fluorescent dye in the form of a dust, or as a solution in sugar water by feeding has definite advantages under some circumstances over liquid dyes used as sprays, or over metallic dusts. However, it must be emphasized that in certain areas at least, naturally occurring fluorescent materials may be found in or on mosquitoes. Such fluorescence may lead to false results and confusion unless the dye selected for use in an experiment is distinc-

DISTRIBUTION OF COLLECTING STATIONS AND RECOVERIES OF CULEX TARSALIS IN 1946-1947



tive in color. Thus, a large series of normal field-collected mosquitoes from any study area must be examined prior to selection of the dye, in order to rule out the possibility of a naturally occurring fluorescent material being mistaken for the dye used.

SUMMARY

The fluorescent dye rhodamine-B has been proven satisfactory for the marking of mosquitoes in flight range studies. Use of this dye and its recognition by ultra violet light after recapture leaves the specimens in suitable condition for other studies, including virus isolation or dissection for *Plasmodia*. Details are given of the methods of applying and recognizing the dye found most satisfactory for field studies.

In 1946 *Culex quinquefasciatus, Culex tarsalis* and *Culex stigmatosoma* were demonstrated to have a flight range of at least 2.5, 0.5 and 1.0 miles respectively.

In 1947 studies, observation of the flight range for *Culex tarsalis* was extended to 2.5 miles, and *Culiseta incidens* and *Anopheles pseudopunctipennis franciscanus* were found at distances of 0.6, and 0.9 mile respectively from the release point.

It is concluded that in Kern County, California, under the conditions of these experiments the effective flight range of *Culex tarsalis, Culex quinquefasciatus* and possibly *Culex stigmatosoma* is at least 1 mile. For protection against disease bearing or pest activities of these three species, mosquito control activities should be carried out for a radius of at least one and a half miles from any population it is necessary to protect.

ACKNOWLEDGMENT

We are especially indebted to Mr. A. F. Geib, Manager of the Dr. Morris Mosquito Abatement District, and the personnel of this organization for the extensive cooperation and assistance given in this study.

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KING HONORS DR. BISHOPP

Dr. F. C. Bishopp of our Bureau of Entomology and Plant Quarantine was recently awarded His British Majesty's Medal for Service in the Cause of Freedom, in recognition of his valuable services to the Allied war effort in various fields of scientific research and development. Lord Inverchapel, the British Ambassador, conveyed his personal congratulations as well. The decoration will be tendered the Chief of Protocol, Department of State, who will hold it until Dr. Bishopp can legally receive it. Because of material shortage in the United Kingdom, it will be some months before the insignia becomes available, but the ribbon will be sent the Department of State in the near future. This is a signal honor for a USDA worker.—(From Vol. 8, No. 6. of USDA, a government publication for Agriculture employees.)

OBSERVATIONS OF HIBERNATING MOSQUITOES IN MASSACHUSETTS

MORRIS BERG AND SHELDON LANG
Communicable Disease Center Activities, U. S. Public Health Service, District No. 1

During the winter of 1944–1945 observations were made on the overwintering of mosquitoes in four war areas of Massachusetts in connection with malaria control and prevention activities of the U. S. Public Health Service. These areas were near Ft. Devens at Ayer, Cushing General Hospital at Framingham, Camp Miles Standish at Taunton, and the Boston Area Station Hospital at Waltham.

During the summer months, mosquitoes were abundant in all of the areas studied. In adult resting stations not affected by control work, several hundred anophelines often were observed at one time; culicines were taken in light traps in numbers over 200 per night; larval collections of both culicines and anophelines yielded 100 or more large larvae per 100 dips on numerous occasions.

Of seventy-five mosquito resting stations utilized for checking the efficacy of the summer control program, seven were observed to contain resting mosquitoes at the end of September, 1944, after the first killing frosts apparently had stopped mosquito breeding. The seven stations were visited weekly throughout the winter and in only three of these were mosquitoes found until March 15, 1945. It is assumed that these individuals oviposited later in the spring. The four species of mosquitoes observed in the stations included *Anopheles quadrimaculatus* Say, *Anopheles punctipennis* Say, *Culex pipiens* Linnaeus, and *Culex apicalis* Adams.

During the observation period from October 1, 1944, to March 15, 1945, the minimum temperature recorded was —8° F. and the maximum 86° F. All of the observation stations were at least partially protected from the elements and temperatures taken at the time of each visit all were within a few degrees of the outside temperature. Immediately after the first heavy frosts at the end of September, few if any mosquitoes were noted. However, during the second week in October, large numbers were observed and from then until the studies ceased, the numbers fluctuated greatly although a gradual but decided decrease occurred.

There was a noticeable activity among the mosquitoes throughout the study period even during the coldest months. Movement within the resting stations was determined by drawing circles of about 6 inches diameter with chalk around selected resting mosquitoes. Each position was identified with a date. It was found that no mosquito occupied the same spot for more than two weeks. Within this period, there occurred at least a slight shifting of position within the circle and frequently a shift to the edge or a few feet beyond the circle. Not infrequently a mosquito would disappear or an apparent new one appear. Even during the dead of winter, a flashlight beam held on a resting mosquito for a few seconds would bring a responsive movement of the legs. If the beam was held on the mosquito for more than a couple of minutes, the insect invariably would fly a short distance.

The darker corners of the resting stations appeared to be most attractive to the resting mosquitoes. As the winter progressed the mosquitoes gradually moved upward and usually were found on the ceiling or the uppermost part of a vertical surface. Crevices, ceiling corners, and small, dark recesses were most attractive. Dampness or dryness did not repel them and they rested without apparent discrimination on brick, cement, stone, wood, rusting steel beams, and copper screening.

At the start of the survey, the anophelines assumed their typical normal resting position with the longitudinal axis of the body at an angle to the resting surface.

As the winter progressed, the resting position changed to that usually described for hibernating anophelines, the bodies pressed to the resting surface with the longitudinal axis parallel to the surface.

The three stations in which mosquitoes occurred throughout the study period are distinguished from the others only in the degree of shelter offered. All three were basement structures. One, the cellar of a stone building originally used as a greenhouse workshop, had walls of brick and stone covered with mortar on the inside and a brick ceiling similarly finished. The floor was partially concrete with the remainder hard packed earth. The second was the cellar of an old vacant house. Here again the walls were of mortared stones with one red brick alcove. The ceiling was of wood with roughly hand-hewn beams. The floor also was of concrete or hard packed earth. The third station was under a New England type barn with a stone foundation and a doorless opening at one end. Here the floor was of earth well saturated with manure and water. The ceiling consisted of rough wooden beams overlaid by crude boards. Hogs or cattle occupied the cellar in varying numbers during the summer. Of all of the other observation stations only one was subterranean, a tunnel in daily use as a passageway for the transportation of ashes from a furnace. This station harbored large numbers of mosquitoes during November and December all of which disappeared by the end of January. It is thought that the mosquitoes may have been disturbed and driven out by the constant use of the passageway.

Although the literature indicates that hibernating mosquitoes have been observed in houses, privies, stables, barns, caves, tree holes, and hollow logs, all available references are concerned with more southerly latitudes. Stations in the above mentioned categories were included in the Massachusetts observations and only the subterranean shelters harbored mosquitoes throughout the winter.

Unpublished data, collected by the office of Malaria Control in War Areas in the U. S. Public Health Service District No. 1, show that *A. quadrimaculatus* adults were collected continuously throughout the winter months at West Point, New York. Here again the collection stations were sub-surface, consisting of concrete target pits on a shooting range. Movement was established by collecting all observed mosquitoes each week and noting that new specimens appeared on the following visit. West Point is slightly south of Massachusetts but has similar climatic conditions and temperature ranges.

In summary, it may be stated that observations in Massachusetts during 1944–1945 indicate that *A. quadrimaculatus, A. punctipennis, C. pipiens,* and *C. apicalis* pass the winter in subterranean resting places that are comparatively well sheltered from the elements. In these places temperatures reached 0° F. and below on occasion. Movement in the hibernating individuals could be stimulated even in the coldest weather by a flashlight beam, and shifts in positions continued throughout the winter period.

RECORDS OF *ANOPHELES QUADRIMACULATUS* SAY FOR THE FLORIDA KEYS [1]

ERNESTINE H. BASHAM [2] AND JAMES S. HAEGER [3]

Anopheles quadrimaculatus Say has been reported by Elmendorf (1941) as occurring in 51 counties in Florida. Prior to 1946, the species had been reported from every county in Florida with the exception of Monroe County,[4] located in the southernmost region of the peninsula and including the Florida Keys.

Near Pinecrest, located on State Road #94 in the northeastern section of the mainland area of Monroe County, four males and eight females of *A. quadrimaculatus* Say were collected July 18, 1946, in an abandoned trailer by D. C. Thurman, Jr. (1948). This collection is the first known record from Monroe County. Pritchard, et al. (1947) state *A. quadrimaculatus* Say is known to occur in the Miami region (Dade County), adjacent to the Florida Keys. However, the species was not found in collections of hundreds of larvae and adult mosquitoes taken in surveys of the Keys in 1945, 1946 and the Spring of 1947.

During an extensive Mosquito Survey of South Florida which began in September, 1947, *A. quadrimaculatus* Say was discovered on the Keys. The following records have been obtained:

Plantation Key, three females collected from a spider web in an unscreened house, November 4, 1947 (James S. Haeger); Rock Harbor, one female taken in a light trap, November 14, 1947; and Big Pine Key State Road Camp #8514, one female taken in a light trap, December 6, 1947.

[1] From Communicable Disease Center Activities, U. S. Public Health Service and the Florida State Board of Health, Jacksonville, Florida.

[2] Entomologist, U. S. Public Health Service.

[3] Entomologist, U. S. Public Health Service.

[4] Florida State Board of Health Records, 1941–1945, unpublished.

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CORRECTION

Vol. 7, No. 4 (December, 1947), under "Association News," page 160, 5th paragraph, first sentence in the summary of Mr. Chester Robinson's remarks, should read: ". . . stated that the principal mosquito problem in his district is *Aedes dorsalis* and *Aedes nigromaculis*. . . ." Since the presentation was oral, the word *quadrimaculatus* was apparently mistaken for *nigromaculis*. Dr. Robert Matheson called attention to the obvious error, and Mr. Robinson has verified the correction.

journal.of.the.american.mosquito.control.

A VESPID PREYING ON ANOPHELINES

H. H. STAGE

Bureau of Entomology and Plant Quarantine
Agricultural Research Administration
United States Department of Agriculture

Early in February 1947, while collecting mosquitoes on the inside of a stable trap at the edge of the jungle near Moengo, Suriname, South America, I noticed a social wasp catching and devouring adult anophelines which had been attracted to the calf bait. Two anophelines were caught and the first was almost completely devoured before I fully comprehended what I saw. The second victim was only partly consumed, because I wanted to lose no time in capturing the predator and bring it back to the States for positive identification.

The first victim apparently had evaded the predator or had possibly been caught while in flight, because my attention was first attracted to the insects as they settled on the screen, the anopheline being securely held by the jaws and feet of the attacker. In less than a minute later the social wasp, a vespid, had pounced upon the second anopheline less than six inches away as the latter was resting upon the screen of the stable trap and, without any apparent struggle, quickly consumed part of the mosquito's abdomen. At that instant the insects were caught in a chloroform tube. Although positive determination was impossible, I am reasonably sure the anopheline was *A. aquasalis* Curry.

During the next two weeks several thousand mosquitoes were captured in stable traps, but I did not witness this interesting phenomenon again.

Identification of the vespid as *Polybia occidentalis parvula* (F.) was kindly made by K. V. Krombein, of the Division of Insect Identification of the Bureau of Entomology and Plant Quarantine.

According to Bequaert (1944), the known range of this vespid is Mexico to Brazil. As far as I have been able to determine, this is the first record of this insect preying on mosquitoes.

Reference

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OBITUARY

Dr. Alfonso Dampf, Professor of Entomology in the National School of Biological Sciences of the National Polytechnic Institute of Mexico, died on March 17. MOSQUITO NEWS was notified of Dr. Dampf's death by notices thoughtfully sent by his widow and by the Director of the School, through Professor Diodoro Antunez Echagaray.

The notice received from Professor Echagaray reads as follows:

"La Escuela Nacional de Ciencias Biologicas del Instituto Politecnico Nacional, tiene la profundia pena de participar a ud. (s) que el dia 17 del actual, fallecio en esta ciudad, el destinguido maestro e investigador Doctor Alfonso Dampf Tenson, despues de 25 años de constante y fructifera labor cientifica en Mexico.

Mexico, D. F., Marzo de 1948
Por el Director,
El Sub-Director
Prof. Diodoro Antunez Echagaray."

Dr. Dampf was a member of many scientific societies not only in Mexico and the United States, but also in various foreign countries.

NEWS AND NOTES

RESUMÉ OF THE 16TH ANNUAL CONFERENCE OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION

HELD AT AGRICULTURE HALL, UNIVERSITY OF CALIFORNIA, BERKELEY, FEBRUARY 12, 13, 14, 1948

A three-day conference highlighted by prominent speakers ranging from coast to coast and a total registered attendance of 175 persons was the feature of California Mosquito Control Association activities during February, 1948. The program included papers by Thomas Mulhern and Robert Yannote of New Jersey; Perry Ruth and R. E. Dorer of Virginia; E. F. Knipling, Washington, D. C.; John Rowe, Kansas City, Missouri; Don Rees, Salt Lake City, Utah; Mitchell Mondala and Frederick Ferguson, Seattle, Washington; Dorothy McCullough Lee, Portland, Oregon; A. W. Lindquist and W. W. Yates, Corvallis, Oregon, all out of state; plus virtually every prominent name in California mosquito and other vector control.

On February 12, the places of the University of California, the California Mosquito Control Association and the State Health Department, in relation to California mosquito control, were reviewed, followed by new information on vectors and reservoirs of certain of the encephalitides; the epidemiology of malaria in California; the scope of the new Bureau of Vector Control; some aspects on fly control; and symposia on new insecticides, their place, toxicities and tolerances, completed the first day's discussions.

The evening session was given over to Association business in which reports were given by the various committees. New officers were elected which made Theodore G. Raley, President; Thomas M. Sperbeck, Vice President and G. Edwin Washburn, Secretary-Treasurer. In addition, Professor W. B. Herms, Jack Kimball and Past President Arthur F. Geib were elected to complete the Association Executive Committee.

The second day began with reports of activities of out of state participants and the reading of papers of absent contributors. Public relations in mosquito control operations, a comparison of California's mosquito control status with other regions and a symposium on the use of the airplane in mosquito control filled out that day's diurnal hours. An evening banquet was held at the Hotel Claremont in Berkeley, featuring an address by E. F. Knipling, United States Department of Agriculture, on "Some Objectives in Research on the Control of Arthropods of Medical Importance."

The final half day of the Conference was confined to specialty subjects presented by California mosquito control workers.

General expression of appreciation of the Conference was characteristic of those who attended. Printed copies of the Proceedings and Papers will be published in the near future.

ENTOMOLOGIST DR. E. F. KNIPLING RECEIVES MEDAL OF MERIT FROM DEPARTMENT OF NATIONAL DEFENSE. "For exceptionally meritorious conduct in the performing of outstanding services to the United States," Dr. Edward F. Knipling, as Director of the Orlando station of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture during the war period, was awarded the Medal of Merit May 20, 1948, by the Department of National Defense. The citation, signed by President Harry S. Truman, which accompanied the award stated that Dr. Knipling "planned and directed investigations for the development of insecticides and repellents for the prevention of insect-borne diseases in the United States Army. As a result of these studies the Armed Forces adopted the use of DDT for the control of insect-borne diseases and new uses and equipment were developed for the dispersing of insecticides by new methods, including the airplane spraying of infested areas. All these research contributions were of inestimable value to the health and morale of United States troops, as well as to the Nation as a whole."

The Medal of Merit, awarded only to civilians, and the Legion of Merit, awarded to military personnel, were authorized by Public Law 671, 77th Congress, approved July 20, 1942, for the purpose of rewarding outstanding and meritorious conduct in the performance of duties in furtherance of the war efforts of the United Nations. The award stems from the Badge for Military Merit, America's oldest decoration, established by George Washington in 1782.

Dr. Knipling was notified early this year that he was to be awarded Great Britain's highest

decoration to civilians, the King's Medal for Service, for the part he carried on in relation to the same investigations.

G. J. HAEUSSLER

The following announcement has been received from the Corporacion Nacional de Turismo, 50 Rockefeller Plaza, New York 20, N. Y.

A course in Tropical Medicine will be given at the Peruvian Summer School, Lima, Peru, July 5 to August 5, 1948.

The subjects to be discussed are "Life at High Altitudes," by Prof. Dr. Alberto Hurtado, "A Study of Determined Tropical Diseases" by Prof. Dr. Telemaco Battistina and "Coca and Medical-Social Problems" by Dr. Carlos Gutierrez Noriega.

All lectures are given in English. Discussion in English.

The fee for the entire course, which includes tuition, accommodation and meals in first class hotels in Lima, classwork and laboratory work, local excursions and a four day (field) excursion to Cuzco, Cajamarquilla, and Pachacamac is $295.00.

Travel from the United States will be by Peruvian International Airways, a direct flight from New York to Lima offering the finest in service. P. I. A. is equipped with the latest in Radar equipment to insure safety and comfort. The cost, including tax, round trip is $715.66.

The group will meet Thursday July 1, 1948, at 86 Vanderbilt Avenue (corner 46th Street—ticket office for P. I. A.) at 12:15 P.M. or at the Marine Terminal, LaGuardia Field, at 1:00 P.M. Scheduled flight 2:00 P.M. arrives 2:10 P.M. next day.

Arrangements for tuition may be made at the office of the National Tourists Corporation of Peru, 50 Rockefeller Plaza, New York. Telephone CIrcle 5-8372.

Arrangements for travel may be made with Mr. Carlos De Lama, c/o Peruvian Consulate, 10 Rockefeller Plaza. Telephone: COlumbus 5-1715.

ARMY ENTOMOLOGISTS ATTEND AMERICAN MOSQUITO CONTROL ASSOCIATION ANNUAL MEETING. The Department of the Army Entomologists in conference at Orlando, Florida, 29 March to 2 April 1948, visited the annual meeting of the American Mosquito Control Association at Fort Pierce, Florida, on 30 March. Papers presented of particular interest to the group were "Mosquito Control in Ohio" by Dr. Herbert Crandall, "The Effects of New Insecticides on Fish and Wildlife" by Dr. J. P. Linduska, "The Army Campaign Against Mosquitoes" by Major Ralph W. Bunn, and the "United States Public Health Service Foreign Quarantine Entomology Relating to Aircraft" by John H. Hughes.

Other highlights of the day were the demonstrations of field equipment for the dispersal of insecticides and participation in the preparation of Committee brochures on "Insecticide Application for Mosquito Control by Ground Equipment."

Army entomologists in attendance were: W. D. Reed, Office of the Chief of Engineers, Washington, D. C.; G. L. Hutton, Office of the Chief of Engineers, Washington, D. C.; Major R. W. Bunn, Office of the Surgeon General, Washington, D. C.; Ray Treichler, Office of the Quartermaster General, Washington, D. C.; I. H. Waller, Headquarters, First Army, Governors Island, New York; C. B. Wisecup, Headquarters, Second Army, Fort George G. Meade, Md.; Major S. J. Carpenter, Headquarters, Second Army, Fort George G. Meade, Md.; K. S. Littig, Headquarters, Third Army, Atlanta, Ga.; Theo McGregor, Headquarters, Fourth Army, Fort Sam Houston, Tex.; M. F. Bowen, Headquarters, Sixth Army, Presidio of San Francisco, Calif.; C. B. Keck, Headquarters, Army Ground Forces, Pacific, Hawaii; R. H. Vincent, Headquarters, Marianas-Bonins Command, Guam, M. I.; R. E. Fontaine, Headquarters, U. S. Army, Caribbean Command, Panama Canal Zone; Lt. H. C. Barnett, Brooke Army Medical Center, Fort Sam Houston, Tex.

W. D. REED

MRS DOROTHY MCCULLOUGH LEE, who will be remembered as the very attractive member who spoke at the Atlantic City meetings in 1947, has just been elected Mayor of Portland, Oregon. According to the May 23 *Sunday Star* of Washington, D. C., Mrs. Lee is the first woman mayor of Portland, and is the only woman who ever served in the State Senate. She takes office next January, and I am sure the entire membership of the AMCA joins with me in wishing her the best of success.

H. L. T.

SALUTATION—The Utah Mosquito Control Association Organized March 20, 1948. A meeting of the various Utah Mosquito Control Agencies was held in the Salt Lake Tribune Auditorium on Saturday, March 20, 1948. The meetings were well attended by representatives from all parts of the state and the many different agencies interested in the work.

The program and meetings were very successful and resulted in the formation of the "Utah Mosquito Control Association." Officers were elected as follows: President, Don M. Rees, Member of the Board of Trustees of the Salt Lake City Mosquito Abatement Dist.; Vice President, Robert A. Wilkins, Supervisor of Salt Lake City Mosquito Abatement Dist.; Sec.-Treasurer, Roy F. Tygesen, Member Board of Trustees, Magna Mosquito Abatement Dist.

Other members of the Executive Committee: The Presidents of the Boards of Trustees of the four organized mosquito abatement districts in Utah.

This organization will function until a Constitution and By-laws are prepared and accepted by the association.

DON M. REES

EDWIN GOULD MALARIA FUND HELPS TO UNDERWRITE THE COST OF PUBLISHING AMCA AIRCRAFT BULLETIN. With reference to the cost of publishing AMCA Bulletin No. 1, "The Use of Aircraft in the Control of Mosquitoes," a letter from H. W. Van Hovenberg addressed to H. H. Stage contains the following paragraphs:

"I am attaching a check made out to Mr. Mulhern in the amount of $400.00 to be used by the Association in completing the publication of the Airspray booklet. You may forward this check to Mr. Mulhern under the following stipulations:

"1. This money will be returned to me by the Association in full whenever the sales of the booklet bring sufficient revenue from all sources to cover the expense of publication.

"2. In case the sales of the booklet fail to bring in sufficient money to repay the entire cost of publication, the Association will return to me such proportion of the $400.00 as this $400.00 bears to the sums advanced by the Association and individuals for the publication of the booklet."

LIST OF ADVERTISERS

	PAGE
Allied Chemical & Dye Corp.	XVI
John Bean Mfg. Co.	VIII
Geigy Co., Inc.	III
Hardie Mfg. Co.	XV
H. D. Hudson Mfg. Co.	XII
Insect Wire Screening Bureau	IX
LeHava Air Services	V
Lawrence Aero Mist Sprayer Co.	X
F. E. Myers & Bro. Co.	VII
New Jersey Mosquito Extermination Assn.	XIV
Renick & Mahoney, Inc.	V
Rohm & Haas	VI
Shell Oil Co.	I
Sky-Spray, Inc.	II
D. B. Smith & Co.	IV
Southern Entomological Co.	XIII
Tobacco By-Products & Chemical Corp.	XI
Todd Shipyards Corp.	VI
R. L. Vannote, Inc.	XI

ASSOCIATION NEWS

A Joint Meeting of the American Mosquito Control Association with the Florida Mosquito Control Association was held at New Fort Pierce Hotel, Fort Pierce, Florida, March 28–31, 1948.

MINUTES OF THE BUSINESS SESSION

MARCH 31, 2:00 P.M.

Call to Order

The meeting was called to order by President H. D. Peters.

Minutes and Secretary's Report

At the request of President Peters, the secretary read the minutes of the last Executive Committee, held at Baltimore, Maryland, on November 21 and 22, 1947, and presented the following information in connection therewith:

The new "Standing Committee on the sale of advertising space in MOSQUITO NEWS" authorized by the Executive Committee has been appointed and is functioning. (See Report below.)

As authorized, a special committee with power to act (Chairman, C. T. Williamson; members, R. L. Vannote, T. D. Mulhern, L. W. Smith, R. D. Glasgow), was appointed to inquire into and take measures to correct the sharp decline in revenue from the sale of advertising space, which had attended the delegation of this branch of Association business to a commercial advertising agency. A conference with officers of the agency having seemed to promise little improvement, in accord with the mutual escape clause, formal notice was given under date of December 6, that the contract would terminate as of June 6, 1948; and a new Standing Committee on the Sale of Advertising Space in MOSQUITO NEWS was at once appointed by the President of the Association, with R. L. Vannote named as Advertising Manager, and Chairman of the Committee. Under the terms of the contract, the agency continued to receive commissions on all collections from advertising in MOSQUITO NEWS regardless of who made the sale, until the termination of the contract on June 6th.

All future correspondence relating to advertising space should be addressed, and particularly all payments for advertising space in MOSQUITO NEWS should be made only to R. L. Vannote, Advertising Manager, 3 Franklin Place, Morris Plains, N. J.

Dr. Glasgow and Mr. Stage have been named to represent the Association at the Fourth International Congresses of Tropical Medicine and Malaria at Washington, D. C., May 10–18, 1948.

A special "Standing Committee on Sustaining Memberships and Endowments" has been appointed, as follows: Chairman, Mr. H. F. Gray, Mr. L. W. Smith, Mr. A. D. Hess. Two other members are authorized, for appointment by Mr. Gray.

The Executive Committee recommends to the Association that dues be increased, beginning January 1, 1949, to the following:

Active Membership, $5.00 per year including MOSQUITO NEWS
Associate Membership, $4.00 per year including MOSQUITO NEWS
Subscription only, $4.00 per year

The Executive Committee has authorized Mr. Stage to proceed with his plan of forming a "Good Neighbor Club," by requesting contributions of the members, to defray the cost of sending MOSQUITO NEWS to workers and organizations in Foreign Countries, where the war has destroyed libraries, etc., or where the gift of such subscriptions would further the interests of this Association. The donor may if he desires designate the recipient, and a contribution of $5.00 will provide a two-year subscription.

The invitation of the Florida Mosquito Control Association to hold the 1948 Annual Meeting jointly with that Association, at Fort Pierce, Florida, was accepted by the Executive Committee, and Mr. R. L. Vannote was named Chair-

man of the Committee on Arrangements, and directed to work out a program which would provide material for a booklet on the subject of "The use of general equipment for the dispersal of insecticides for mosquito control."

The Executive Committee ordered that a booklet "The Use of Aircraft in the Control of Mosquitoes" be printed, and financed as proposed by Mr. Stage. The original plan failed to provide sufficient funds to accomplish the objective, and a substitute plan, involving advance sales at a reduced price was adopted as follows:

For advance purchases, or purchase orders to March 15, 1948:

Single copies—$1.00 to anyone
50 copies—10% discount
100 copies—20% discount

For regular sale, after March 15, 1948:

	Members	*Non-members*
Single copies	$1.25	$1.50

Twenty-five new active and fifty-one associate members were admitted on November 21, 1948.

Miss Helen Louise Trembley, Associate Editor, Reviews and Abstracts, was authorized to arrange exchanges with other publications for review purposes.

The President was authorized to appoint a special committee on the "Administration of Industrial Research Projects."

The publication of a membership list in MOSQUITO NEWS was authorized.

President Peters presented to Past President Harry Stage, on behalf of the membership, a bound book of testimonial letters.

Financial Report

AMERICAN MOSQUITO CONTROL ASSOCIATION

TREASURER'S REPORT

March 25, 1948

Cash on hand at last audit, May 31, 1946		$844.28
Receipts:		
Dues, active members	$1,448.50	
Dues, associate members	1,035.66	
Advertising in MOSQUITO NEWS	1,812.12	
Sales, Subscriptions, etc.	1,433.23	
Miscellaneous other (mainly airspray book)	529.80	
Total Receipts		6,258.51
Sub Total		$7,102.79
Expenditures:		
MOSQUITO NEWS, Printing only	$5,582.73	
MOSQUITO NEWS, Other costs, incl. postage, etc.	239.37	
MOSQUITO NEWS Sub Total	$5,822.10	
Miscellaneous Special (Airbook)	310.63	
General Expenses, mail, meeting rooms, etc.	394.92	
Total Expenses		6,527.65
Cash on hand, May 25, 1947		$575.14
Cash received at Annual Meeting		110.00
		$685.14

SUPPLEMENT TO TREASURER'S REPORT

March 25, 1948

Cash		$575.14
Accounts Receivable:		
Active members (194)	$776.00	
Associate members (152)	380.00	
Other	192.47	
Est. Ads. in MOSQUITO NEWS, V. 7, No. 4	258.00	
		1,606.47
		$2,181.51
Accounts Payable:		
Mailing (Airbook)	$13.30	
" "	3.84	
Secretary Expense 11 to 47, for 1947	58.20	
Boyd Printing Co. from Statement 2/2	485.75	
Statement 2/7	6.51	
Statement 2/24	19.28	
Statement 3 3	4.83	
J. Ford Flagg, 1 23 48	36.50	
2/6/48	58.00	
Mrs. R. Cleland, clerical 3 3 48	3.50	
Mrs. Tindall "	14.00	
		703.71
Apparent Free Balance		$1,477.80
MOSQUITO NEWS, V. 8, No. 1:	Estimates	
Printing	$799.73	
Ads deducted	275.00	
		$524.73
Airspray Booklet:	Estimates	
Costs: Printing	$990.48	
Engravings	192.58	
Mailing	13.30	
"	3.84	
Clerical (Stage)	8.50	
Postage	15.00	
Envelopes	58.00	
		$1,281.70
Sales:		
Advertisements	$350.00	
Pur. Orders (405 cop.)	364.90	
Cash (371 cop.)	348.45	
		1,063.35
Net Deficit		$218.35

Present Status of Membership:	Domestic	Foreign	Total	
Active Members	240	15	255	$1,020.00
Associate Members	249	28	277	691.50
Subscriptions	102	30	132	396.00
	591	73	664	$2,107.50

In view of the status of the funds of the Association at this time, the treasurer recommends:

1. That the greatest possible economy be practiced in getting out the subsequent numbers of MOSQUITO NEWS.

2. That a special committee be appointed to further push the sale of the Airspray Booklet.

3. That the publication of the booklet to be prepared as the result of this conference be accomplished by a special funding plan, which will assure that it will be financed without the desperate effort that has been necessary to float the Airspray Booklet, and furthermore, that a special committee be composed to handle the merchandising of this proposed ground spray booklet, whenever the financing is assured. This latter recommendation is made in view of the tremendous amount of detailed correspondence, etc., which is involved in such a sale as this, and the corresponding fact that the Association is not in a position to pay for special clerical help to handle this detail.

4. That an accelerated drive be made to increase membership, with the objective to having over 1000 members and subscribers by 1949.

Respectfully submitted,
THOMAS D. MULHERN,
Secretary

On motion by Mr. Stage, seconded by Mr. L. W. Smith, the foregoing report was duly adopted with no dissenting votes.

New Members

The following applications for membership, which have been received since the Executive Committee meeting on November 21, 1947, were approved on motion by Mr. Williamson, seconded by Dr. Bishopp, and duly adopted:

ACTIVE MEMBERSHIP

Alexander M. Cochran, N. J.
Norman R. Ehmann, Calif.
J. L. Geisman, N. J.
Nicholas Grabler, N. J.
Richard Hollyer, N. J.
Jack Kimball, Calif.
E. J. Komar, Ohio
William M. Miller, Calif.
Dr. W. B. Owen, Wyo.
L. J. Pontzler, N. J.
John A. Rowe, Missouri
David Postle, Buffalo, N. Y.
T. M. Sperbeck, Calif.

ASSOCIATE MEMBERSHIP

Wesley G. Bruce, Savannah
Mal Carberry, Calif.
Alexander Ehrlich, Penna.
Pablo Cova Garcia, Venezuela
Leo Gardner, Calif.
Wm. H. Hutson, Ark.
Dale W. Jenkins, Maryland
Jean Laffoon, Iowa
Clarence W. Lewis, Canada
A. Russell Morrison, N. J.
Arthur H. Neill, Puerto Rico
Ronald Senior-White, Trinidad
Joe Schuh, Oregon
Lilburn E. Thompson, Mexico
Clem Toone, Utah
J. D. Vertrees, Oregon
Vernon Walker, Calif.
Joseph Wickersham, Penna.

Members admitted on applications signed at annual meeting, and amounts collected at same time.

Active Membership:		
R. E. Fontaine, La.	$4.00	
Charles F. Gerlach, Mich.	4.00	
Juan a Granados, Cuba	4.00	
Samuel A. Harper, Fla.	4.00	
John W. Hession, Conn.	4.00	
J. Henry Rogers, Fla.	4.00	
K. D. Quarterman, Ga.	4.00	
A. M. Weiss, N. Y.	send bill	
		$28.00
Associate Membership:		
Edward M. Becton, Fla.	$2.50	
Frank A. Burkard, N. Y.	2.50	
T. E. Duffey, Fla.	2.50	
H. G. Ford, Fla.	2.50	
John C. Long, Pa.	2.50	
John W. Randolph, Fla.	2.50	
Samuel M. Rogers, Fla.	2.50	
George E. Schultz, N. Y.	2.50	

Arthur Spencer, Fla.	2.50	
Ray Treichler, Washington, D. C.	2.50	
George A. Warren, Fla.	2.50	
		27.50
Application received too late for admission at Annual Meeting:		
Calvin C. Kiker, T.V.A., active membership, pd.		4.00
Dues paid by old members:		
Arthur Hill, for 1948 and 1947	$8.00	
R. P. Templeton, 1948	4.00	
Joe W. Rogers, 1948	2.50	
Ray H. Sammis, two years	8.00	
		22.50
		$82.00
Sold one copy MOSQUITO NEWS, V. 8, No. 1		.75
Sold 21 copies Airbook for cash		27.25
		$110.00
Check from H. W. Van Hovenberg, Edwin Gould Malaria Fund, for use in financing Airspray Booklet		400.00
		$510.00

Mr. Hess reported as chairman that the Membership Committee has prepared a plan of action and hopes to serve many more members. He indicated that the committee would probably call upon many of the regular members for assistance. Other members of this committee are T. G. Raley, C. C. Deonier, Hernando Rey, John H. Huber, Luis Vargas, Helen Louise Trembley.

DUES FOR 1949

Mr. Hess, speaking for the Membership Committee, strongly urged that for 1949 the Associate Member classification be retained, and the dues therefore not be increased more than $1.00, for it was his feeling that a greater increase would probably result in the withdrawal of a number of these members. He pointed out that the broader objective of the Association could be best served only by having a large membership, and further, that an increased charge which caused a loss of members could only be offset by securing more members as replacements.

Mr. Hess moved that for 1949 dues be established as follows:

Active members	$5.00
Associate members	3.00
Subscriptions	4.00

The motion failed of passage.

Mr. Mulhern moved that a letter ballot be taken on a proposal to increase dues for 1949 to the above rates. The motion failed to pass.

Mr. Williamson moved that the recommendation of the Executive Committee, made at the November 21, 1947, meeting be accepted, and that 1949 dues be made

Active members	$5.00
Associate members	4.00
Subscriptions	4.00

This motion also failed to pass.

Dr. Pepper moved that the matter of dues be referred to the Board of Directors of the new incorporated Association, for action when and if the incorporation is completed. This motion was passed.

ADVERTISING

Mr. Vannote, chairman of the Advertising Committee, reported that the Committee has become active, and expects to effect an increase of 50% in the advertising for June 1948 compared with the March number.

CONSTITUTION

Dr. Glasgow presented the report of the Constitution Committee, and after full discussion, the report was duly adopted, with no dissenting votes, on motion by Mr. Williamson, seconded by Mr. Stage. The report follows:

H. D. Peters, President,
American Mosquito Control Association

Dear Sir:

Your Committee on Constitution and By-Laws has met at Ft. Pierce, Florida, on March 28–30, 1948, and after due consideration reports and recommends as follows:

1. The Executive Committee of the present unincorporated American Mosquito Control Association be directed to form a non-profit corporation, organized under the laws of the State of New Jersey, to be designated as the American Mosquito Control Association, the organizing trustees of which corporation shall be Roland E. Dorer, Robert D. Glasgow, Harold F. Gray, Willard V. King, Thomas D. Mulhern, Travis E. McNeel, H. Duke Peters, Don M. Rees and Lester W. Smith, or such other persons, not exceeding a total of nine trustees, as may be designated by the Executive Committee.

2. That upon receipt of a certified copy of the articles of incorporation from the Secretary of State of New Jersey, the following actions be taken:

(a) The present membership of the unincorporated American Mosquito Control Association be sent letter ballots for the purpose of voting,

> *first,* whether they wish to transfer their membership from the present unincorporated association to the new incorporated association, and *second,* whether they will authorize the Executive Committee of the present unincorporated association to transfer the assets and liabilities of the present association to the new incorporated American Mosquito Control Association?

(b) Upon receipt of the certified copy of the articles of incorporation, the trustees of the incorporated American Mosquito Control Association be requested to formulate and adopt by-laws of the corporation which shall incorporate the constitution and by-laws of the present unincorporated American Mosquito Control Association, with any necessary amendments thereof, in so far as they are in conformity with the laws governing corporations in the State of New Jersey.

(c) Upon receipt of an affirmative vote of a majority of the active members of the present unincorporated American Mosquito Control Association upon the transfer of the assets and liabilities of said association to the corporation, the Executive Committee shall transfer the property, lands, assets and liabilities of said association to the corporation.

(d) Upon completion of the transfer of the aforesaid assets and liabilities, the Executive Committee of the unincorporated American Mosquito Control Association shall declare such association dissolved and its functions and purposes taken over by the incorporated American Mosquito Control Association.

Robert D. Glasgow, *Chairman*
J. Mulrennan
Bailey B. Pepper
Harold F. Gray
R. E. Dorer

NOMINATIONS

Mr. Harry Stage reported for the Nominations Committee that in view of the proposed reorganization of the association, the Committee had decided to withhold making nominations at this time, and made a motion that the present officers be continued until the proposed incorporation be consummated or rejected. If rejected the Nominations Committee will then submit a slate of candidates. Mr. Vannote seconded the motion and it was duly adopted.

RESOLUTION

Mr. Bradley presented the report of the Resolutions Committee, and moved its adoption. The motion was seconded by Dr. F. C. Bishopp and duly adopted, as follows:

I. Whereas the American Mosquito Control Association now is concluding a

joint annual convention with the Florida Anti-Mosquito Association at Fort Pierce, Florida, to which many individuals and agencies have given generously of their time, effort, and facilities, thus contributing greatly to the success of these most informative, interesting, and enjoyable sessions,

Therefore be it resolved that the Association extend its thanks and appreciation to the following in writing:

1. The Convention Committee: Will I. Fee, Chairman, Norman Platts, J. B. Hull, Warren L. Blackman.
2. The Entertainment Committee: Dewey Wilcox, James Barry, J. B. Brewer, Lane H. Jennings, J. R. Merritt.
3. The Fort Pierce Woman's Club: Miss Gwendoline Jones, President; Mrs. Luba Ringdahl, Chairman.
4. The Business and Professional Women's Club of Fort Pierce: Mrs. T. V. Hubbard, President.
5. The Registration Committee: Mrs. Ernestine Basham, Chairman.
6. Motorcade Committee: Joseph Yates and Jack Harris (Kiwanis); J. K. Walker, Jr., and James Pace (Lions); Charles Kime and W. G. Padrick, Jr. (Rotary).
7. The Committee on Demonstration of Equipment: J. B. Hull, Chairman.
8. The Florida State Board of Health, The Florida State Chamber of Commerce and the Mayor of the City of Fort Pierce.
9. The New Fort Pierce, The Burston, and other hotels of Fort Pierce.
10. And that particular appreciation be expressed to the Sanitary Commissioners of St. Lucie County who provided the excellent fish fry which was so delightfully served by Mr. and Mrs. R. A. Hayes and the ladies who assisted them. Also to Mrs. John B. Hull, Mrs. Norman Platts, Mrs. Max Osburn, Mrs. T. E. McNeel and the wives of the Sanitary Commissioners who provided the Hospitality Hour and constantly attended the bar which was bountifully supplied with orange juice by the Cherokee Fruit Company, The Indian River Cooperative Association (Mr. Dan McCarty) and Mr. Norman Platts.

II. Whereas the report of the Ft. Myers Beach Citizens Committee for Mosquito Control presented by Mr. Murray Thwaites for 1947, indicated the possibility for effective work by a small enthusiastic group for the protection of an isolated community, be it resolved, that the American Mosquito Control Association commend Mr. Thwaites and his committee for their public spirited effort which should encourage other such communities to join in the war on mosquitoes.

III. Whereas the Florida State Board of Health during the past year has successfully established a Division of Entomology under the leadership of Mr. John A. Mulrennan, one function of which will be the coordination of mosquito control activities throughout the state to the end that expanded and more effective work may be performed. Therefore, be it resolved, that the American Mosquito Control Association commend the Florida State Board of Health for this progressive action.

March 31, 1948
Fort Pierce, Florida

Robt. L. Vannote
Fred C. Bishopp
G. H. Bradley, *Chairman,*
Resolutions Committee,
Ameircan Mosquito Control Assn.

IV. Whereas the current interest in the designing of new machines for insecticides distribution is producing a variety of useful equipment for mosquito control, much of which, however, still is in the developmental stage,

Therefore, Be it Resolved that the Association commend this progressive work and go on record as encouraging Federal, State, Private Agencies, and individuals, to give an increasing amount of attention to the invention of new devices and the development and perfection of existent types of equipment.

Whereas, sandflies constitute a serious

insect problem in many coastal cities of Florida, affecting both personal comfort of residents and income derived from tourists, and

Whereas, sufficient research has not yet been done to intelligently control sandflies,

Be it Resolved: That the American Mosquito Control Association and Florida Anti Mosquito Association go on record as endorsing requests for the appropriation of sufficient Federal or State funds to establish suitable research activities, designed to solve problems concerning these pests, and that the State Chamber of Commerce and other civic organizations be urged to request funds from both State and Federal Legislatures, for the initiation of such projects.

R. L. Vannote
F. C. Bishopp
G. H. Bradley, *Chairman,*
Resolutions Committee,
American Mosquito Control Assn.

Whereas, the American Mosquito Control Association and the Florida Anti-Mosquito Association, meeting in joint session at Fort Pierce, Florida, have been informed that a measure for the ratification of the World Health Organization, which was passed by the United States Senate and approved by the House Foreign Affairs Committee, has been tabled by the House Rules Committee, Be it Resolved that these Associations go on record as strongly favoring ratification of the World Health Organization by the United States, and that these Associations urgently request the House Rules Committee to give prompt and favorable consideration to this measure.

Fort Pierce, Florida
March 31, 1948

Robert L. Vannote
Fred C. Bishopp
G. H. Bradley, *Chairman,*
Resolutions Committee,
American Mosquito Control Assn.

REPORT OF THE A.M.C.A. GOOD NEIGHBOR CLUB

Since its inception late in 1947 the Good Neighbor Club of the American Mosquito Control Association has received $60.00 for the purchase of 24 volumes of MOSQUITO NEWS. These 96 numbers of our Association's periodical have been forwarded to the following twelve foreign libraries at no expense to the Association save for transportation charges from New Brunswick, N. J., to Washington, D. C.

University of the Philippines
Herran Street
Manilla, Philippine Islands

Malaria Institute of India
22 Alipore Road
Delhi, India

School of Hygiene
Leophoros Alexandras 196
Athens 6, Greece

Chinese Committee on the Distribution of Books
Academia Sinica
37 b Brenan Road
Shanghai, China

Research Institute
10 Sh. Kasr El Aini
Cairo, Egypt

Institute of Tropical Hygiene
Mauritskade 57
Amsterdam, Netherlands

Agricultural Experiment Station
Paramaribo
Dutch Guiana, South America

Ecole de Medicine Tropical de l'etat
Parc Duden, Forest
Brussels, Belgium

Instituto Superiore di Sanita
Viale Regina Margherita 299
Rome, Italy

University of Queensland
Brisbane, Australia

Dr. Kamal Goldsmith
Assam Railroad and Trading Co.
Ledo, Assam, India

University of Paris
15 Rue de l'Ecole de Medecine
Paris, VIe, France

When these volumes arrive in Washington they are stamped "With the compliments of the Good Neighbor Club, American Mosquito Control Association" and taken to the Smithsonian Institution which sends them to the various embassies. These in turn forward them to their respective countries without additional charges.

To date the following members of the Association and their friends have contributed to the Club:

Helen Louise Trembley
Helen Sollers
F. C. Bishopp
R. D. Glasgow
C. C. Deonier
Robert L. Armstrong
F. E. Lyman
Louis J. Richards
Stephen S. Easter
E. F. Knipling
H. H. Stage
Division of Insects Affecting Man and Animals
Bureau of Entomology and Plant Quarantine

Won't you join us? The Executive Committee has voted us permission to purchase two annual subscriptions to MOSQUITO NEWS for each $5.00 collected by the Club, or one annual subscription for $3.00. Here is a chance (1) to contribute to the scientific libraries in needy countries; (2) to encourage additional subscriptions by foreign libraries; and (3) to increase the circulation of and subsequent interest in MOSQUITO NEWS and in the American Mosquito Control Association.

We solicit your interest and your contributions. You may name the library or institution if you wish.

H. H. Stage, *Chairman*
Good Neighbor Club

EDITORIAL SECTION

". . . OH, WHAT A BEAUTIFUL DAY . . ."

INCREASED INCOME FROM SALE OF ADVERTISING SPACE

Thanks to the unselfish efforts of Bob Vannote, our new Advertising Sales Manager and his collaborators, this number of MOSQUITO NEWS carries 15½ pages of advertisements. Only one previous number (June, 1946, with 17 pages) has ever carried as much.

Interested members had observed, and a recent editorial directed attention to the alarming slump in income from the sale of advertising space (from a total of 54½ pages in 1946 to a total of 40½ pages in 1947) which had followed the transfer of this item of Association business from member management to management by a commercial advertising agency. Prompted by this experience, the Executive Committee invoked the cancellation clause in our contract with the commercial agency, and Bob generously agreed to assume responsibility for this function, with the proviso that every member of the Association should help. If each of us will now do his full share, we can easily double our income from the sale of advertising space, with a corresponding increase in the number of pages that MOSQUITO NEWS can afford to print.

PROGRESS TOWARD REORGANIZATION

It has been repeatedly urged on this page, that the Association has now grown in membership, in geographic representation, and in the complexity of its activities to a degree that makes imperative a careful consideration of appropriate changes in its present form of organization.

At the Florida meetings it was voted that appropriate steps be taken to constitute the Association a Body Corporate, with the resulting legal advantages and responsibilities. Related questions will be submitted to the membership for action.

Following incorporation, will come a full appraisal of Association objectives and responsibilities, as well as of current and contemplated new activities, with careful consideration of appropriate changes in the By-laws.

The Association is truly "growing up."

REVIEWS AND ABSTRACTS

MALARIA IN BRAZIL. By Mário Pinotti, A Folla Medica 28(12). June–July, 1947.

The National Malaria Service, created on April 2, 1941, is the director agency for the control of malaria in Brazil. It is composed of central, technical, administrative services and field laboratories. The central services are divided respectively into the following sections: section of epidemiology; section of organization and control; section of hydraulics; section of administration and Institute of Malariology. The whole country is divided into seven regions. Each region is subdivided into smaller areas for administrative purposes.

The National Malaria Service has 5 sanitary doctors, 53 medical malariologists, 3 entomologists, 4 engineers, 34 technicians and 13 experts in topography.

The study of the geographic distribution of malaria in Brazil is still incomplete. Judging by the present available data, malaria is endemic in about 930 counties of Brazil. It is more prevalent in the coast and the valleys of the larger rivers.

The malaria problems differ according to the local topographic and climatic conditions. The large area of the country, the difficulties of transportation (especially during the war), the urgent need of solution for the various problems of different States, the still deficient number of specialized technicians make the work of visiting the whole country a task still unfinished. The geographic distribution of the anophelines is therefore incompletely known. According to the author, the anophelines which have been found in Brazil are of two genera: *Chagasia* and *Anopheles*. Fifty-four different species have been found in Brazil, including the *A. gambiae*. This species invaded the Northeast from the African continent, but is now eradicated.

Eight species have been found naturally infected: *A. darlingi, A. tarsimaculatus, A. albitarsis, A. cruzii, A. bellator, A. homunculus, A. strodei,* and *A. noroestensis*. However, the last two have little if any epidemiological importance.

The most dangerous is the *A. darlingi* because of its habits and widespread geographic distribution. It has been found infected many times in 8 States. The coast of Santa Catarina, Paraná and Rio Grande do Sul is the zone of influence of the *Kerteszia*.

The control of malaria consists of measures against the parasite and the mosquito. Until recently the campaign was empiric but now it is based on scientific and epidemiological data.

The drugs are administered to the patients in fixed units by the federal, regional and ecclesiastic authorities. In 1944, 1945 and 1946, the National Malaria Service examined 977,631 blood samples from suspected cases. The laboratory has confirmed the diagnosis in 489,433 cases. The consumption of 10,670,464 tablets of antimalarial drugs was reported.

Sometimes pyrethrum insecticides were used against adult mosquitoes. Now DDT is the agent used and 62 small villages have been DDT sprayed.

In combating the larval stage the author points out that small hydrographic works are made (drainage, filling, etc.) and larvicidal agents are used (Paris green, larvicide oil, etc.).

Up to 1946 the National Malaria Service has built 80,877 meters of underground drains and 345,504 meters of lined ditches.

Special reference is made to the work which is going on in the South of the country. In this region malaria is transmitted by an anopheles of the subgenus *Kerteszia* which breeds in plants called "gravatás" (Bromeliaciae).

These mosquitoes transmit the disease in and outdoors, the reason why the attack on the imaginal stage has not been made. The author also discusses the methods of killing the plant, its removal by hand and the destruction of woods in the suburban areas with subsequent planting of vegetables and flowers. The latter method is more satisfactory and the one which seems to the author to give the best results.

The paper includes a large list of the geographic distrbution of malaria in Brazil. It is also illustrated with a few interesting photographs.—FERNANDO BUSTAMANTE, Serviço Nacional de Malária, Rio de Janeiro, Brazil.

MALARIA CONTROL IN VILLAGES OF QUETTA (BALUCHISTAN) WITH DDT. by M. K. Afridi and M. L. Bhatia. Indian Jl. Malariology, 1(2): 279–287, 1 map. June 1947.

An emulsion containing 2.5% DDT was sprayed in the villages of Quetta (Baluchistan, W. Pakistan), with a total population of about 20,000. The malaria was highly endemic and the vectors were *Anopheles superpictus, A. culicifacies* and *A. stephensi*. The dosage of DDT applied was unusually low (25–38 mg. per sq. ft.). The first round of DDT spraying done in July was applied only outdoors in the three regions of the villages, but after 4 weeks the second round application was: Region A—outdoor and indoor, B—indoor only, and C—outdoor only.

Malaria was effectively controlled in the Regions B and C as shown by the drop of spleen rates. However in the Region A (with both outdoor and indoor spraying) it had a contrary result with a significant increase of both the parasite and spleen rates. This unexpected finding was explained as most probably due to the fact that the controlled population contracted malaria infection during visits to the neighboring unsprayed villages. Unfortunately, owing to the small staff, no record was taken on the density and the dissections of the anopheline adults.

The actual cost *per capita* for two sprayings was 2.4 annas (U. S., $0.05) but effective control could

be secured by indoor spraying applied once a year with DDT suspension at 50 mg. per sq. ft. with a cost of 1.4 annas (U. S., $0.03) exclusive and 2.0 annas (U. S., $0.04) inclusive of supervision by a medical officer.—C. Y. CHOW, Malaria Laboratory, National Institute of Health, Nanking, China. At this writing, at Department of Entomology, Cornell University, Ithaca, N. Y.

A BRIEF ACCOUNT OF THE *Anopheles* (MALARIA) ERADICATION IN KARPAS—CYPRUS, 1946. By M. Aziz, 1947. Roy. Sanit. Inst. Jour. 67(5):498–509.

Cyprus has swung into the spotlight of the mosquito world with its program for the eradication of malaria by a total war on anophelines. During an intensive 9-months' campaign the island has eliminated all *Anopheles* from an area approximately 800 square miles. The last anopheline in this section was found during the week of November 23, 1946, and through January 31, 1947, no others had been seen. As the report does not continue beyond the latter date, we will look forward to further details concerning the outcome of the undertaking. Dr. Aziz and his coworkers deserve great credit for the success gained in the first round of their campaign.

The plan of eradication was based on that used in Brazil and Egypt but modified to suit local conditions. Wisely, the staff attempted elimination on a small scale at first and chose the Karpas Peninsula which is bounded on two sides by the sea. In order to fully protect the peninsula from mosquito infiltration, about 250 square miles on the landward side was included. The *Anopheles* encountered in Cyprus are *superpictus* Grassi—responsible for 95% of the malaria there—*bifurcata* Meig., and *elutus* Edw.

As a starting point the island had at its disposal a well-trained staff of anti-malarial workers who were ready for immediate action. One interesting feature of the project was the division of the whole area into blocks, and the results of weekly findings were plotted on a chart. At first practically every block showed mosquito infestations but both the graphs and the maps vividly demonstrate the rapid decline in mosquito populations. By September nearly all the anophelines had been killed.

Almost all of this work was accomplished on foot, by men using flit-type hand sprayers with modified long tubes to prevent the operator from bending over. The insecticide employed was 4 to 5% DDT in gas oil. Although destruction of the larvae was the main objective in the program, residual DDT was applied to outbuildings in October.

So successful has this campaign been that work was initiated during the winter months of 1947 to eradicate anophelines from the entire island. It appears that H. H. Stage's prediction (Natl. Malaria Soc. Jour. 5(2):101, 1946) that species eradication might be accomplished by DDT on a small island, will shortly be realized.—HELEN SOLLERS, U. S. Bureau of Entomoogy and Plant Quarantine.

THE IMPORTANCE OF COVERAGE IN DDT RESIDUAL HOUSE SPRAYING FOR THE CONTROL OF *Anopheles quadrimaculatus* MOSQUITOES. By R. H. McCauley, Jr., R. W. Fay, and S. W. Simmons. Pub. Hlth. Rpts. 63(13):401–407. 1948.

Tests made by releasing *Anopheles quadrimaculatus* mosquitoes in rooms in which a hand sprayer had been used to apply 5%-DDT-xylene emulsion as a residual spray at the rate of 200 mg. of DDT per square foot indicated that (1) satisfactory control of this mosquito cannot be expected from a spot treatment in which only the predictable resting places in a room (such as corners and angles of walls and ceiling, undersides and backs of furniture) are sprayed; (2) coverage of the predictable resting places plus the walls and ceilings in a room is a more effective method of application than that in which only the walls and ceilings are sprayed; (3) the amount of total area covered with DDT not only affects the initial knockdown efficiency of the treatment of the room, but the residual quality as well; (4) based on the criterion of 4-hour knock-down, complete treatment is experimentally more effective than the regular treatment; (5) efficient application is necessary for the greatest residual effect of DDT spray.—R. H. MCCAULEY, JR., C.D.C., U. S. Public Health Service, Savannah, Ga.

THE MOSQUITOES OF ILLINOIS (DIPTERA, CULICIDAE). By Herbert H. Ross. Bulletin of the Illinois Natural History Survey. Vol. 24, Art. 1, pp. 1–96, frontispiece and 184 figures. Urbana, Illinois. August 1947.

The purpose of this work, as stated by the author, "is to provide means for making mosquito control programs more effective, first by furnishing illustrated keys and descriptions for the identification of mosquito species that occur in Illinois and states similar in climate, and second by summarizing information regarding the distribution, biology and habitat preferences of the species." In the opinion of this reviewer this object has been attained most admirably. The first sixteen pages are devoted to the subject in general, with the biology of the eggs, larvae, pupae and adults, hibernation, habitat preferences, seasonal distribution, distribution pattern within the state, economic importance, control considerations, and the techniques of collecting, preserving, study and rearing treated. This is followed by a section on classification and a listing of the species. All ten Nearctic genera of Culicinae are found in Illinois, and the 52 species are distributed among them as follows: *Aedes* 23, *Anopheles* 5, *Culex* 8, *Culiseta* 2, *Mansonia* 1, *Megarhinus* 1, *Orthopodomyia* 2, *Psorophora* 8, *Uranotaenia* 1, and *Wyeomyia* 1. Generic keys to the larvae, adults, male genitalia, and female genitalia are given with excellent illustrations accompanying them so that the characters are

clearly depicted and close at hand. These generic keys are followed by a treatment of the separate genera and their included species, with keys to the species where these are necessary. This section is also very fully illustrated and the drawings of the various aspects of the male and female genitalia being particularly valuable. A key to the subgenera of *Aedes* based upon the female genitalia is also given. The larva, female and male of each species is described, there is a brief statement on its biology and habitat preference, and the Illinois records are listed alphabetically by town. The work is commendable in every way, but particularly for the quality and orignality of its keys, and the abundance and excellence of its illustrations. It should be in the hands of anyone wishing to identify mosquitoes of the Mississippi drainage.—ALAN STONE, Div. Insect Identification, B. E. P. Q., U. S. D. A.

THE OLFACTORY RESPONSES OF FEMALE MOSQUITOES. By Edwin R. Willis. Jour. Ec. Ent. 40(6):769–778, 1947.

This report gives the results of experiments planned to give an answer to the question of whether mosquitoes will respond to odor given off by the human body. In order to test the responses of these insects to odor without interference from other stimuli such as temperature, light, humidity, etc., the author resorted to the use of an insect olfactometer. The apparatus used is a modification of a model known to entomologists as the Hoskins insect olfactometer. It is provided with a chamber in which the test animals are given a choice of responding to the inflow of two currents of air. The flow of air through one circuit in the apparatus has passed over the arm of a man while the other circuit is free of human odor. All factors other than odor are identical in the two currents of air. A diagram of the author's apparatus is given.

Females of *Anopheles quadrimaculatus* and *Aedes aegypti* were used as test animals. A complete description is given of the experiments with each species of mosquito and the results are presented in 4 separate tables. During the tests the inflow of air was maintained at 34° C. and a relative humidity of 70 to 85%. Mosquitoes were used in lots of 50 for each test. Results of some 250 tests are presented. The data show conclusively that females of both speceis respond to human odor in the olfactometer.

Since it had been suggested by other workers that carbon dioxide eliminated by breathing might be a factor in attracting mosquitoes to a host, the author tested responses to this gas. It was found that carbon dioxide in concentrations of 1, 10, and 50% in air was not an attractant to females of either species when tested in the olfactometer.—WM. B. OWEN, The University of Wyoming, Laramie, Wyo.

THE USE OF AIRCRAFT IN THE CONTROL OF MOSQUITOES. American Mosquito Control Association Bulletin No. 1, 1948. 46 pp. (Price $1.25 to members, $1.50 to non-members.)

This is a factual, up-to-date report on the use of aircraft in the control of mosquitoes. The first in a series, to cover all aspects of mosquito control, this "hand book" was prepared by a group selected from organizations active in control work. An accumulated total of about 1,000,000 acres treated by airplane, served as a source of practical information. The editorial board, Russell, Bradley, Hess, Mulrennan, and Stage, ably screened the wealth of information presented by the various working committees.

Prepared and presented to serve as a day to day guide for both novice and expert, no detail on the use of aircraft for mosquito control has been overlooked. Supplemented with 45 illustrations (including halftones and diagrams) graphically portraying every step from field operations to detailed diagrams of equipment, the bulletin fills a long standing need for all health and pest control agencies.

A brief history of the use of aircraft in mosquito control is given as well as suggestions for future research. There are chapters on types of aircraft and dispersal equipment, DDT formulations and specifications, operational procedures, situations in which aircraft are useful, the appraisal of results, sample record forms for ground inspectors and pilots, and a guide for the analysis of expenditures. The precautions to be taken against injurious effects on wildlife, beneficial insects, and animal and vegetable products are outlined. Public relations are discussed as are legislation, liability, insurance, and contracts; and civil air regulations are given together with a list of regional offices. Finally, there are lists of sources of equipment and supplies and of aircraft spraying and dusting services. The selected bibliography contains 68 references.—T. G. RALEY, Consolidated Mosquito Abatement District, Selma, California.

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